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**working paper  
department  
of economics**

AN AGING SOCIETY:  
OPPORTUNITY OR CHALLENGE

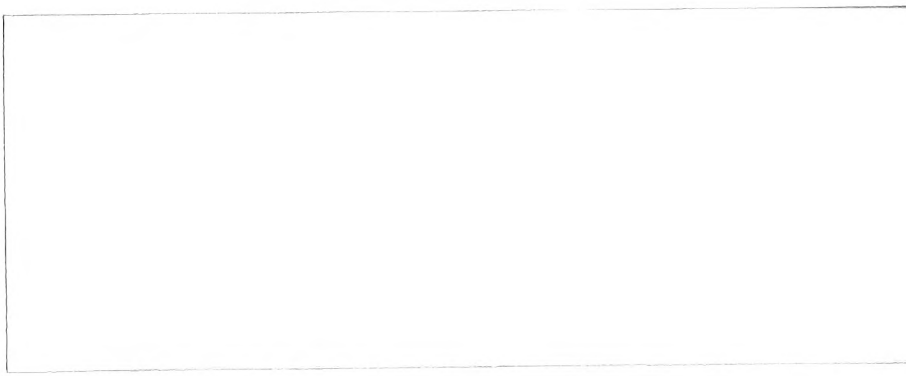
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No. 553

May 1990

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AN AGING SOCIETY: OPPORTUNITY OR CHALLENGE

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April 1990

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### Summary

The American population and that of the industrialized world is aging rapidly. The suggestion is commonly made that increases in saving are necessary to prepare for increases in future dependency. This paper argues to the contrary that demographic change represents as much of a macroeconomic opportunity as a challenge, and that ceteris paribus, the appropriate policy response to recent and projected demographic change is a reduction in national saving. However, demographic changes are not nearly large enough to justify the sharp decline in U.S. national saving during the 1980s.

Our analysis proceeds in five steps. First, we note that estimates of the coming dependency burden need to recognize that the share of dependent children in the population will fall, that the labor force will grow more productivity as it matures, and that a more slowly growing labor force will require less investment to maintain a given degree of capital intensity. Taking account of these factors, it appears that the consumption cost of demographic change over the next 60 years will be less than 10 percent. This is equivalent to a .1-.2 percent per year slowdown in productivity growth, or about three times as large as the "peace dividend" the economy will enjoy over the next decade.

Second, we observe that the good news—reduced labor force growth and fewer dependent children—comes before the bad news of increased dependency. Furthermore, saving for increases in the dependent population encounters diminishing returns as labor force growth slows. Using a stylized Ramsey-type optimal growth model, we find that the appropriate policy response to future demographic changes is a reduction in national saving. This conclusion is robust with respect to a variety of assumptions about preferences, technology, and the demographic future.

Third, allowing for international capital mobility reinforces our conclusions. Because labor growth decelerates faster and dependency increases come more quickly abroad, demographic factors push toward making the U.S. a capital importer over the next decade. This drives down rates of return, making increased saving less attractive.

Fourth, in a more speculative vein we consider the response of technical change to changes in labor force growth rates. Contrary to the often-asserted dynamism hypothesis that young populations are better able to innovate and thus grow more quickly, we find using international comparisons that a reduction in labor force growth is likely to be associated with an increase in the rate of productivity growth.

Fifth, we assess the implications of our results for fiscal policy. Demographic change appears likely to raise private saving in the near term, weakening the case for higher government saving. Arguments that efficiency considerations related to "tax smoothing" require accumulation of a Social Security trust fund are shown to be quantitatively unimportant.

We conclude by arguing that while a Social Security trust fund may be justified as a politically convenient way to raise the American national saving rate, it is not justified by forthcoming demographic changes.



An American woman reaching childbearing age in 1960 would expect 3.6 children; an identical woman in 1990 would expect only 1.9 children. This dramatic demographic change makes it almost inevitable that the American population will age rapidly over the next 50 years. By 2025, the share of the American population over 65 will exceed the share of Florida's population that is aged today. The ratio of the number of retirees to the number of workers will have risen by nearly two-thirds. Even more dramatic demographic changes are occurring abroad. The share of the Japanese population that is over 65 will rise from 11% to 19% over the next two decades. If current fertility levels are maintained until 2050, the population of West Germany will not only age but will shrink by more than one-third.

These demographic changes have aroused considerable anxiety. Economic concerns have focused on the burden that increased dependency will place on the economy in general and the Federal treasury in particular, as well as on the possible loss of dynamism that will occur as population growth slows. Concern about increased dependency has led to a potentially radical change in American fiscal policy. To insure that Social Security taxes will be sufficient to fund benefits over the next 75 years, and to help the nation save in anticipation of increased demographic burdens, the Social Security legislation enacted in 1983 calls for Social Security taxes to exceed benefits over the next 30 years. This surplus will be accumulated in a trust fund, which will peak at 29% of GNP in 2020 and then be drawn down as the population ages.

This paper steps back from the current political debate over the Social Security trust fund and examines the more general question of how serious a macroeconomic problem aging represents and how policy should respond to it. We focus primarily on issues relating to saving and capital accumulation. We

do not consider the broader question of whether the current U.S. national saving rate is too high or too low, but focus on the partial effect of demographic changes on the optimal level of national saving. In addition, we consider the effects of demographic change on productivity growth and the optimal timing of tax collections.

Our general conclusion is that demographic changes will improve American standards of living in the near future, but lead to modest reductions over the very long term. Ceteris paribus, the optimal policy response to recent and anticipated demographic changes is almost certainly a reduction rather than an increase in the national saving rate. Slowing population growth will reduce the investment that must be devoted to equipping new workers and housing new families, while making it easier for the United States to attract foreign capital. While there are many reasons for arguing that the United States currently saves too little, anticipated demographic change is not one of them.

Our analysis proceeds in five steps. First, we assess the magnitude of the coming dependency burden. While it is true that the share of the population that is over 65 will increase sharply, it is also true that the share of children in the population will decline over time, and that the fraction of the labor force that is near peak productivity will increase. Using information on projected fertility, mortality and labor force participation rates as well as data on health care costs and the spending of different age groups, we assess past and future dependency trends. We find that demographic changes unaccompanied by changes in capital intensity would reduce per-capita incomes by between seven and twelve percent over the next sixty years, but would actually increase incomes over the next twenty years. In only one of the next six decades will demographic changes have as large an impact on living standards as the "peace dividend" is likely to have in this

decade. The decline in living standards caused by the increased dependence would be fully reversed by a .15% per year increase in productivity growth.

Second, we consider the consequences of the slower labor force growth that presages the increase in the retired share of the population. Between 2010 and 2060, the labor force is expected to decline slightly, compared with an average increase of 1.6% annually between 1950 and 1990. The projected decline in the labor force growth rate will permit a three to four percent reduction in the share of net investment in total income without reducing capital intensity. Since reduced labor force growth will occur before dependency burdens increase, projected demographic changes raise the short-term consumption path even if the steady-state consumption level declines. We show that in a standard growth model with plausible parameter values, optimal consumption typically rises in response to a demographic shock like that experienced in the United States over the last three decades.

Third, we consider the implications of integrated world capital markets for our analysis. The degree and speed of population aging in the other major OECD countries, particularly West Germany and Japan, is more dramatic than that in the United States. This increase in dependency in the rest of the OECD will coincide with a deceleration in labor force growth rates. This means that along an optimal path, the rest of the world will export capital to the United States. This tends to increase U.S. consumption and reduce saving in the short run relative to the path that would obtain if capital were internationally immobile.

Fourth, we go beyond the standard growth theoretic approach and ask whether demographic changes are likely to affect the rate of technical change. With slow labor force growth, labor is scarce; this may induce more rapid

technical change. Such effects would sharpen our conclusion that diminished fertility represents an opportunity rather than a problem. Using international cross-section time series data for the 1960-1985 period, we find some evidence that countries with slower labor force growth experience more rapid productivity growth. The estimates suggest that the reduction in labor force growth projected for the next forty years may raise productivity growth enough to fully offset the consequences of increased dependence. These results are uncertain. A more definitive finding is the absence of any support for the pessimistic view that aging societies suffer reduced productivity growth.

Fifth, we consider the implications of our results for fiscal policy. Since demographic changes over the next decades are not likely to be associated with reduced private saving, our analysis suggests that they do not present a reason for reducing the budget deficit. There remains the question of efficiency in tax collection. Maintaining current service levels for the elderly will require an increase in government spending from about 32 to 37% of GNP. Since the deadweight loss from taxation rises with the square of the tax rate, financing these expenditures on a pay as you go basis will involve higher deadweight losses than maintaining a constant tax rate. We find however that these effects are likely to be small, amounting to at most several tenths of a percent of annual GNP.

We conclude by discussing the implications of our results for Social Security, intergenerational redistribution more generally, and for population and immigration policy. Our findings suggest that population aging does not constitute a strong argument for the accumulation of a large Social Security trust fund, although if national saving is deemed to be inadequate for other reasons, the trust fund may be a convenient way to increase it.



## 1. The Burden of Increased Dependency

The economic consequences of population aging depend on the nature of the underlying demographic change as well as the relationship between the resource needs of individuals at different ages and their capacity for self-support. This section presents our estimates of the economic burden of increased dependency, noting the uncertainties associated with each step in the calculation.

### 1.1 Changing Demographic Structure

Figure 1.1 plots the Social Security Administration's projections of the number of persons aged 65+ as a fraction of the population aged 20-64 between 1950 and 2050.<sup>1</sup> Figure 1.2 plots the total dependency ratio, the number of children plus elderly as a fraction of the working age population. The figures show the Social Security Administration's intermediate projections (the middle line) as well as outlying projections making more extreme assumptions about fertility and mortality changes. The projections agree in suggesting that the fraction of the population over age 65 will increase, and the fraction of the population under 20 will decrease, over the next 50 years. There is very little change, however, over the next decade.

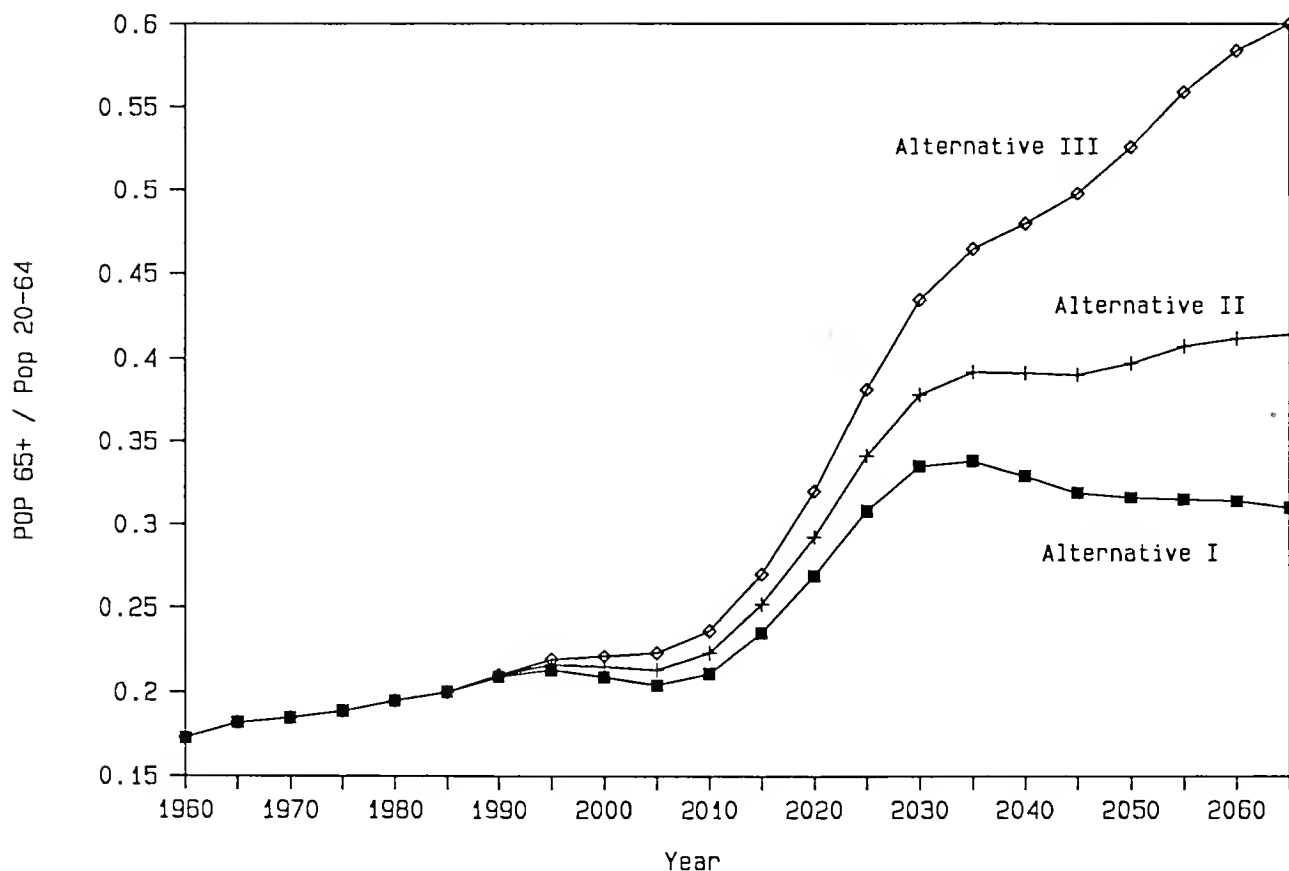
Declining fertility is the principle source of changing demographic patterns.<sup>2</sup> In stable or declining populations, young cohorts account for a smaller share of the total population than in rapidly growing populations. In

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<sup>1</sup>These projections are taken from Social Security Administration (1988a) and unpublished data from the Social Security Administration underlying the published projections.

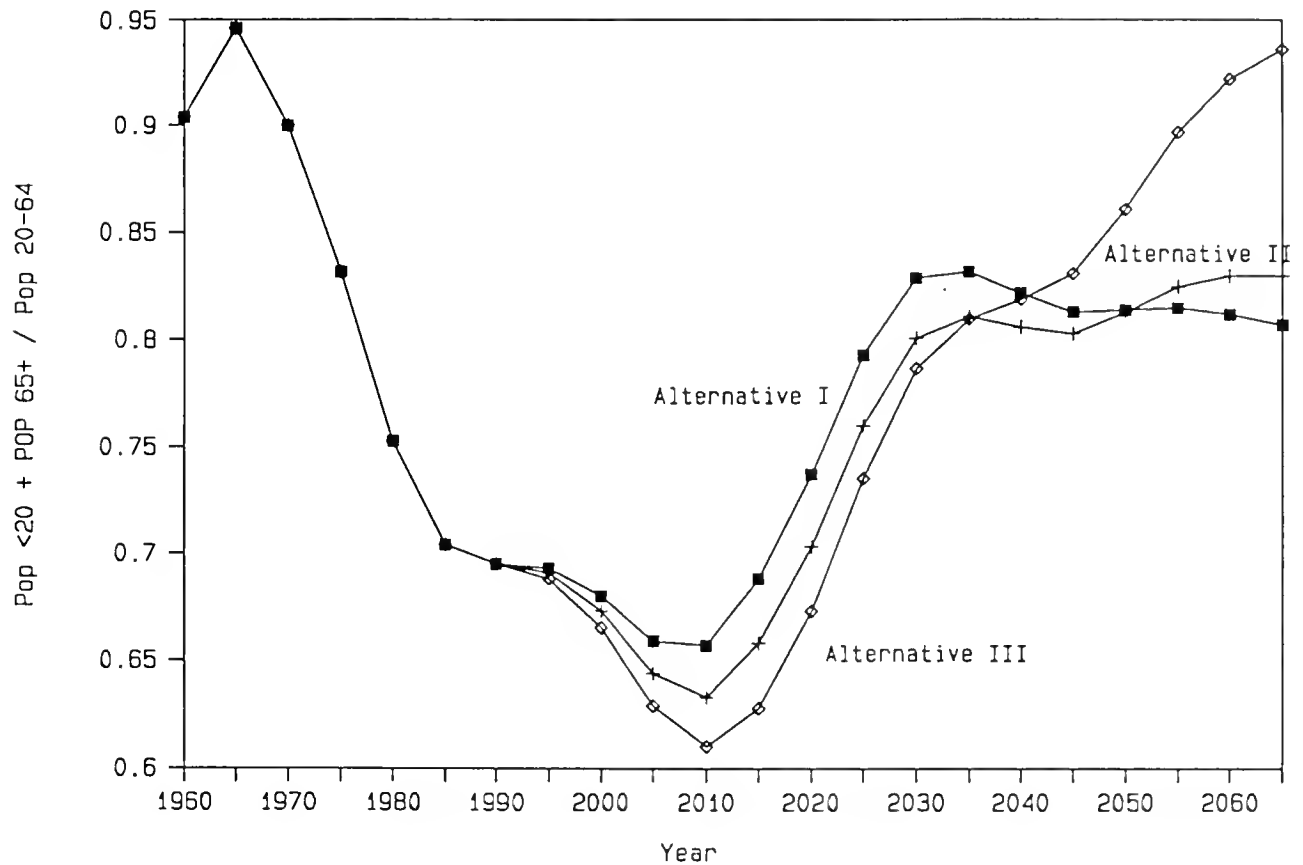
<sup>2</sup>The relative importance of fertility declines, mortality improvement, and international migration are discussed in OECD (1988).

Figure 1.1: Elderly Dependency Ratio, 1950-2065



Source: Social Security Administration (1988a).

Figure 1.2: Total Dependency Ratio, 1960-2065



Source: Social Security Administration (1988a).

the years following World War II, the total fertility rate in the United States rose from 2.4 in 1945 to a peak of 3.7 in 1957. Fertility declined sharply during the late 1960s and early 1970s, falling to 1.7 — well below replacement levels — by 1976. Since then, fertility has increased slightly, averaging 1.8 in the mid-1980s. Preliminary data for 1989 suggest continued increase, to 2.0. These changes have important implications for the demographic structure of the population over the next half century.

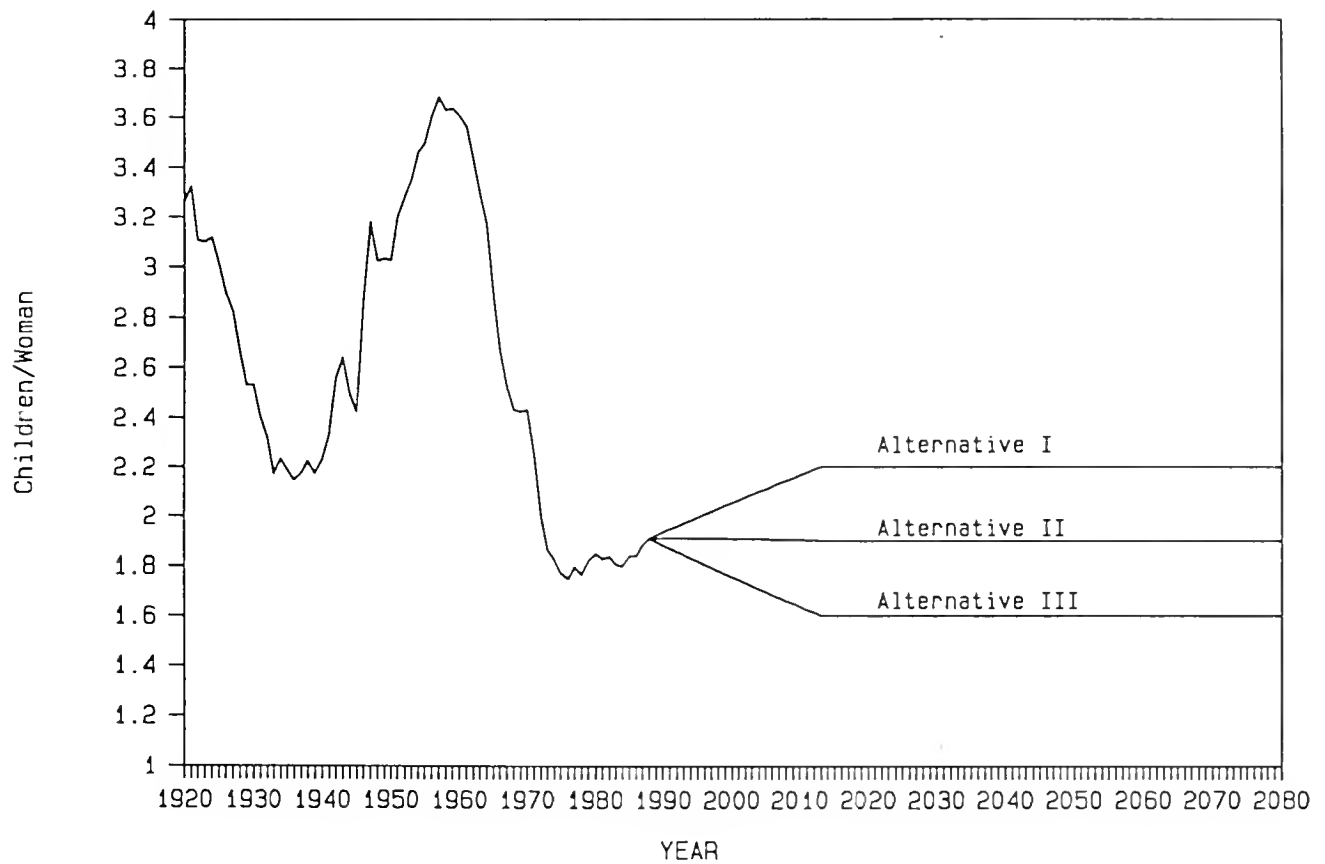
The demographic effects of falling fertility have been reinforced by improvements in old-age mortality. In 1960, life expectancy for a 65-year-old man was 12.9 years, compared with 15.0 years in 1990. The mortality improvement for women has been even more pronounced, with life expectancy at age 65 increasing from 15.9 to 18.8 years during the last three decades. Current projections call for further improvements to life expectancies at age 65 to 18.0 years for men, and 22.1 years for women, in 2060.<sup>3</sup>

Long-term demographic projections like those in Figures 1.1 and 1.2 are uncertain for several reasons. First, fertility forecasts are subject to large standard errors and are notoriously inaccurate. This is illustrated by Figure 1.3, which displays historical fertility rates and the various Social Security Administration projections for the next half century. The range of historical experience dwarfs the range between the Social Security Administration's optimistic and pessimistic projections. Even the factor of two difference between the predicted share of the population aged 65+ in 2050 in the optimistic and pessimistic projections probably understates the true

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<sup>3</sup>These data are drawn from Social Security Administration (1990), Table 11. More detailed information on mortality improvements can be found in Poterba and Summers (1987).

Figure 1.3: Historical and Projected  
Fertility Rates, 1920-2080



Source: Social Security Administration (1988a).

degree of demographic uncertainty.<sup>4</sup> Postwar fertility projections in the United States anticipated neither the beginning, nor the end, of the baby boom.

A second important source of demographic uncertainty is the future course of immigration. The Social Security Administration's intermediate forecasts assume net immigration of 600,000 persons in each year until 2065. This is roughly the annual level of net legal and illegal immigration in the late 1980s. Assuming a constant immigrant flow for the next seventy-five years ignores potential changes in either immigration policy or the level of illegal migration. The age structure of the population is sensitive to the level of immigration, because immigrants on average are younger than non-immigrants. Borjas (1990) reports that only 3.1% of those who immigrated to the United States between 1975 and 1979 were over 65 in 1980, compared with 10.6% of the non-immigrant population. Higher immigration during the next half century would reduce dependency burdens.

Uncertainty about future mortality gains is a third, but less important, source of randomness in demographic projections. Most of the forecast rise in the number of persons over age 65 is the result of large birth cohorts in the 1950s and 1960s. Even doubling the projected gains between 1990 and 2060 in life expectancy at age 65 would increase the number of elderly in 2060 by less than 20%, and change the ratio of the elderly to the working age population by less than eight percentage points.

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<sup>4</sup>The pessimistic case assumes an ultimate fertility rate of 1.6, high for example in contrast to West Germany's current rate of 1.3. On the other hand, Figure 1.3 may be deceptive in that uncertainty regarding the average fertility rate over a 75 year period may be much less than the uncertainty regarding fertility rates at any point in time.

Although there is much uncertainty regarding the future age composition of the U.S. population, the broad trend toward a rising average age, more dependent elderly, and fewer dependent children is indisputable. Moreover, uncertainty about long-term demographic change should not cloud the relatively certain short-term demographic outlook. Labor force growth in the next two decades, for example, is largely forecastable given the fertility experience of the last two decades. Along many dimensions, the near-term effects of demographic change operate in different directions from the long-term changes. To illustrate this we now explore alternative ways to calibrate the shifting burden of demographic change.

## 1.2 The Support Ratio

Demographic shifts affect the economy's consumption opportunities because they change the relative sizes of the self-supporting and dependent populations. We summarize these changes in the support ratio, denoted  $\alpha$ , which we define as the effective labor force (LF) relative to the effective number of consumers (CON):

$$(1.1) \alpha = \text{Support Ratio} = \text{LF/CON} = \text{Effective Labor Force/Effective Consumers.}$$

The share of the population over 65 is one, but not the only, determinant of this ratio. The support ratio is also influenced by the relative consumption needs of persons of different ages, as well as by changes in the retirement age, labor force participation rates, and the earning power of those who are working. Because there are several approaches to measuring and projecting each of these factors, we present several different measures of the support

ratio.

The first issue in measuring the support ratio concerns the relative consumption needs of persons at different ages. One assumption, which we label CON1, defines effective consumption as if all persons have identical resource needs:

$$(1.2) \quad \text{CON1} = \sum_{i=1}^{99} N_i.$$

where  $N_i$  is the number of persons of age  $i$ . This measure of needs is implicit in the commonly-cited total dependency ratio shown in Figure 1.2.

An alternative approach involves differentiating the resource needs of those at different ages. We develop this approach in a second measure of effective consumption needs, CON2, which has three parts: private non-medical expenses, public education expenses, and medical care. For private nonmedical outlays, we follow Lazear and Michael (1980) in assuming that all persons aged 20+ have identical needs, while those aged 0-19 (18 in their work) have needs equal to one-half those of adults.<sup>5</sup> For public education expenses, we assume per capita outlays of \$2553 (1989 dollars) per person aged less than 20, \$309 for persons aged 20-64, and \$84 for those over 65. These estimates are explained in more detail below. For medical care, we assume that needs are proportional to total spending by age: \$1262 per person-year for those aged 0-

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<sup>5</sup>Lazear and Michael (1980, p.102) estimate that a child raises equivalent scale consumption for a husband-wife family by 22.2%, or by 44.4% as much as the average consumption of either parent. There is some evidence that non-medical consumption needs of the elderly may be lower than those for younger persons. For example, the USDA poverty line assumes that food expenditures by the elderly are ninety percent of those for prime-aged individuals. The ongoing trend toward more elderly living in single households, however, suggests that the relative expenditure needs of the elderly may rise in the future.



64, and \$5360 for those aged 65+.<sup>6</sup> Adding together these three components of the equivalence scale, we construct CON2 as .72 times the number of persons aged 0-20, plus the number of persons aged 20-64, plus 1.27 times the number of persons aged 65+.

The relative needs of elderly and non-elderly consumers can be affected by demographic factors such as mortality improvements. Schneider and Guralnik (1990) observe that only 3% of those aged 65+ reside in nursing homes, while 15% of men and 25% of women aged 85+ are in such homes. The high cost of nursing home care (\$23600 per resident-year in 1985) makes it an important contributor to the total cost of caring for the aged population.

The appropriate weighting of young and old dependents may depend on more than their consumption demands. Many of the transfers to children take place within the family, while those to elderly dependents are largely mediated by the government. A Scandinavian proverb, brought to our attention by George Akerlof, suggests that "one mother can care for ten children, but ten children cannot care for one mother." Individuals may derive more pleasure from caring for children than for elderly dependents, making the burdens of an increasingly elderly population more onerous than the burdens of caring for a

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<sup>6</sup>These relative medical costs are based on the current age structure of the elderly population. As the average age of those over 65 rises, however, the relative cost of medical care for the elderly will increase. In 1987, total health expenditures for persons aged 65-69 were \$3728, compared with \$9178 for those aged 85+. Holding age-specific expenditure patterns constant at their 1987 level, average spending per person over age 65 would be approximately 10% higher with the age composition which is expected to prevail in 2060 rather than that prevailing in 1990.

young population.<sup>7</sup>

We also consider two different measures of the effective labor force. The first, LF1, assumes that all persons aged 20–64 are in the labor force, while those below age 20 or above age 65 are not:

$$(1.3) \quad LF1 = \sum_{i=20}^{64} N_i.$$

Our second measure, LF2, recognizes that both human capital and labor force participation rates vary by age. We use data on the average 1989 earnings of persons of each age (measured in five-year intervals)<sup>8</sup>, along with Social Security Administration forecasts of age-specific labor force participation rates, to estimate LF2:

$$(1.4) \quad LF2 = \sum_{i=15}^{99} w_i * LFPR_i * N_i.$$

This recognizes that the earning capacity of a society with a high fraction of persons in middle age is higher than that of a society with many new entrants to the labor force.<sup>9</sup>

### 1.3 Support Ratio Projections, 1990–2060

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<sup>7</sup>Provided the "warm glow" of caregiving does not affect the marginal utility of consuming goods, it should not affect our equivalence scale weighting of different-aged households. It will affect the total utility of households.

<sup>8</sup>These data are from the Bureau of Labor Statistics, Usual Weekly Earnings of Full-Time Wage and Salary Workers and Usual Weekly Earnings of Employed & Part-Time Wage and Salary Workers. We adjust part-time workers to full-time equivalent employees.

<sup>9</sup>This labor force concept only includes market activity, neglecting the value of labor devoted to household production. It may therefore overstate the historical changes in the effective labor force which were partly due to rising market labor force participation by women.

Since the level of the support ratio is less informative than its changes from year to year, we focus on  $\% \Delta \alpha_t$ , the percentage change in the support ratio between 1990 and year  $t$ :

$$(1.5) \quad \% \Delta \alpha_t = (LF_t / CON_t) / (LF_{1990} / CON_{1990}) - 1.$$

We report support ratios corresponding to each combination of effective labor force and effective consumption measures.

Table 1.1 presents these four measures of the change in the support ratio. The upper panel, which shows the historical and projected changes in LF and CON, demonstrates that regardless of measurement method, growth in both the labor force and consumption requirements decline during the next half century. For example, the earnings-weighted labor force grew at a 1.7% annual rate during the 1980s, but will shrink in four of the five decades between 2010 and 2060. In the nearer term, labor force growth also slows. By the first decade of the next century, labor force growth is only one fourth its rate during the 1970s. Total equivalent consumption needs, which grew at a 1.1% annual rate during the 1980s, rise by less than one tenth of one percent per year between 2040 and 2060.

The lower panel in Table 1.1 and Figure 1.4 show the percentage change in the support ratio. Four conclusions stand out. First, since both of our measures of the labor force grow more slowly than population during the next seventy years, there is a long-run decline in the support ratio. The magnitude of this decline is more sensitive to our assumptions about consumption needs than to our measure of the effective labor force.<sup>10</sup> When

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<sup>10</sup>For the period 1950–1990, the support ratios are sensitive to our choice of labor force concept. This is due to the significant changes in labor force participation rates during this period, particularly among women.

Table 1.1: Support Ratios, United States, 1950–2060

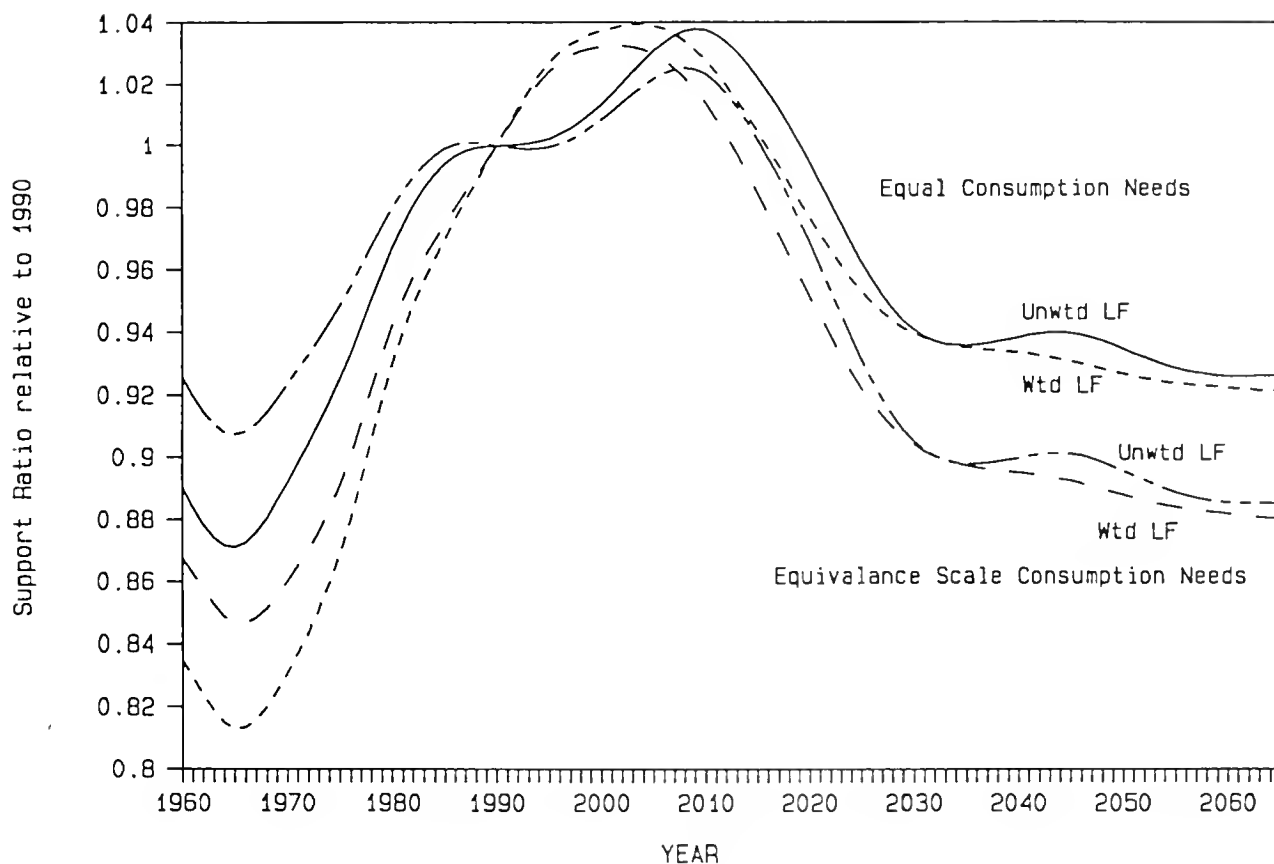
A. Growth in Labor Force and Needs				
Period	Labor Force Growth		Consumption Needs Growth	
	Population 20–64	Earnings- Weighted Population	Total Population	Equivalence Scale Population
1950–1960	0.74%	1.18%	1.77%	1.66%
1960–1970	1.25	1.19	1.24	1.28
1970–1980	1.73	2.05	0.91	1.13
1980–1990	1.29	1.69	0.95	1.08
1990–2000	0.83	1.07	0.70	0.75
2000–2010	0.80	0.48	0.57	0.65
2010–2020	0.06	–0.03	0.48	0.60
2020–2030	–0.26	–0.10	0.29	0.42
2030–2040	0.11	0.07	0.14	0.17
2040–2050	0.00	–0.03	0.04	0.05
2050–2060	–0.06	–0.02	0.03	0.05

B. Percentage Changes in Support Ratios				
Needs:  Labor Force:	Equal Per Capita Consumption (CON1)		Equivalence Scale Consumption (CON2)	
	Population 20–64 (LF1)	Earnings- Weighted (LF2)	Population 20–64 (LF1)	Earnings- Weighted (LF2)
1950	–1.4%	–11.5%	1.4%	–9.0%
1960	–10.9	–16.5	–7.4	–13.2
1970	–10.8	–16.9	–7.7	–14.0
1980	–3.3	–7.0	–2.0	–5.8
1990	0.0	0.0	0.0	0.0
2000	1.3	3.7	0.8	3.2
2010	3.8	2.8	2.3	1.4
2020	–0.5	–2.3	–3.1	–4.8
2030	–5.9	–6.0	–9.5	–9.6
2040	–6.2	–6.6	–10.0	–10.5
2050	–6.5	–7.3	–10.4	–11.2
2060	–7.4	–7.8	–11.5	–11.8

Note: Panel A shows geometric average annual changes in labor force and consumption needs under the population and weighting schemes. Panel B shows percentage changes in support ratios, relative to the 1990 benchmark. The earnings-weighted labor force uses contemporaneous and projected labor force participation rates and the 1987 age-earnings profiles for men and women to form effective labor forces.

Figure 1.4: Support Ratios, 1960-2065  
Relative to 1990



Note: Figure shows the support ratio, the ratio of the effective labor force to effective consumption needs. The ratio is normalized to 1.0 in 1990.

Source: Authors calculations and Social Security Administration (1988a)

consumption needs are assumed to be equal for persons of all ages, the support ratio declines by 7.4% (7.8%) between 1990 and 2060 for LF1 (LF2). When we adjust consumption needs using equivalence scales, the decline in the support ratio is more pronounced: 11.5% and 11.8% for LF1 and LF2, respectively.

It is difficult to know whether seven or eleven percent represents a large or a small burden spread over seventy years. It corresponds to between a .10% and .15% reduction in the annual productivity growth rate, which is small relative to the uncertainty in secular productivity growth. It represents three to four times as large a cost as the peace dividend that the United States is likely to enjoy over the next decade. In yet another metric, a three to four year increase in the average age at retirement, or a nineteen percentage point increase in female labor force participation, would be needed to offset the increase in dependency.

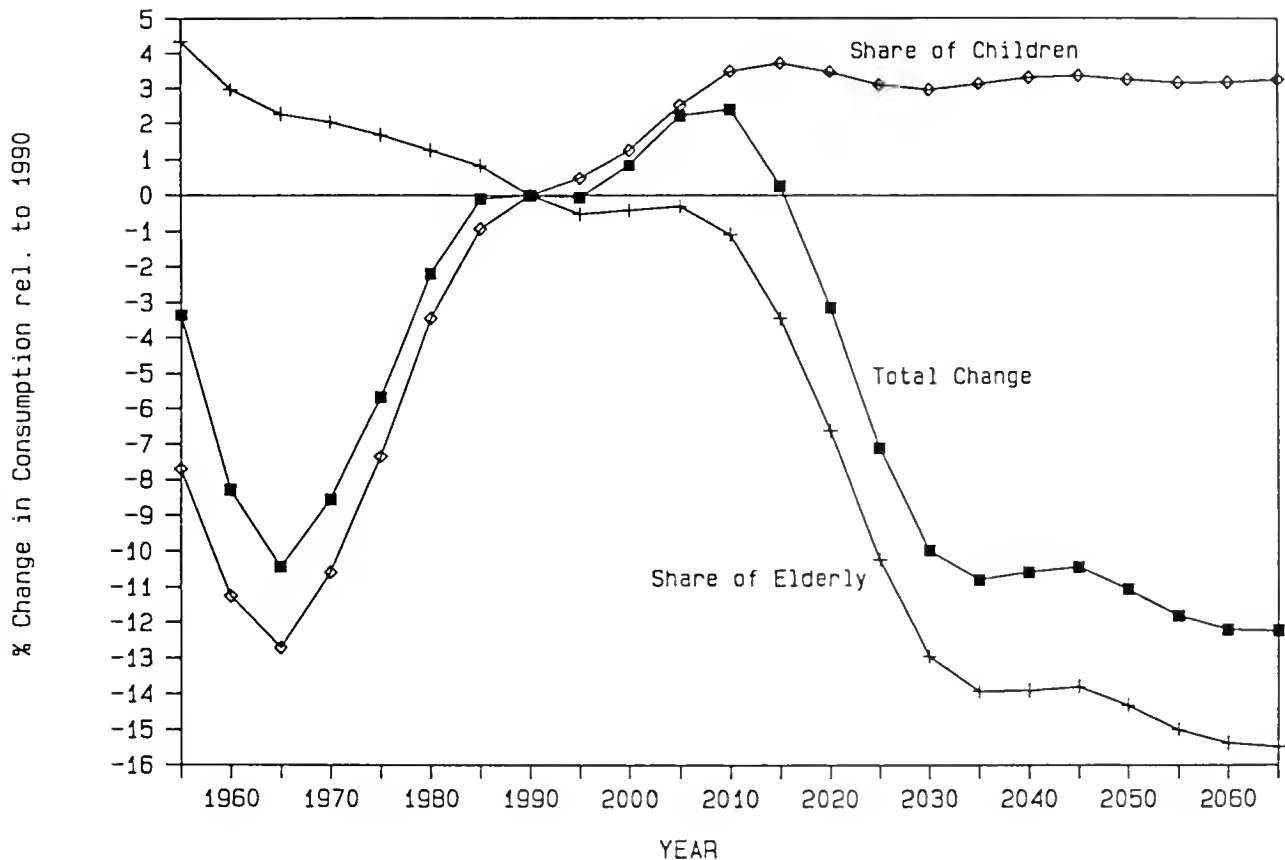
Second, in the next three decades there is a decline in economic dependency (a rise in the support ratio) because the declining number of dependent children more than offsets the rising number of dependent elderly. Between 1990 and 2010, when the baby boom generation is part of the labor force and relatively small birth cohorts are retiring, the labor force grows more rapidly than the dependent population. This leads to an improvement in the support ratio by 2010.<sup>11</sup>

Figure 1.5 provides further detail on the differential burdens of young and aged dependents. It plots the contributions of both children and the elderly to the support ratio defined using LF2 and CONS2. In this case  $\alpha =$

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<sup>11</sup>Measures which define effective consumption with less weight on children show smaller gains in the support ratio during the next two decades. If the equivalence scale for children is set equal to zero, the support ratio actually declines by between one and two percent during the 1990–2010 period.

Figure 1.5: Contribution of Young and Aged Dependents to Percentage Changes in The Support Ratio, 1955-2065



Note: The Figure decomposes changes in the Support Ratio into a part due to changes in the growth of children, and a part due to changes in the share of elderly, based on equation (1.6). The decomposition uses LF2 and CON2 as the labor force and needs measures.

$P/(C+P+E)$ , where  $P$  is the number of prime age adults,  $C$  the number of effective children, and  $E$  the number of effective elderly dependents. The percentage change in the support ratio can be written in terms of the percentage change in its components:

$$(1.6) \quad \hat{\alpha} = (\hat{P} - \hat{C}) * [C/(C+P+E)] + (\hat{P} - \hat{E}) * [E/(C+P+E)].$$

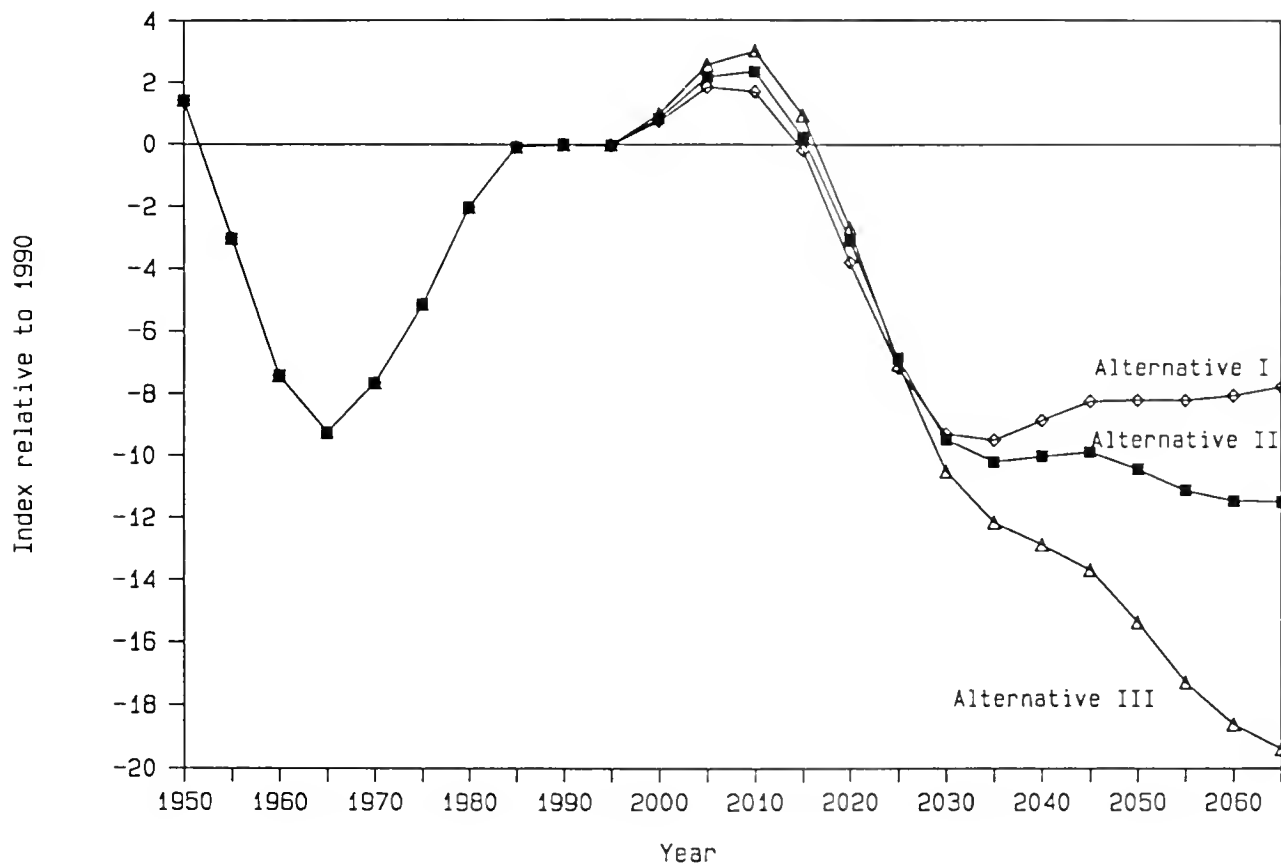
The first term is due to differential growth rates of the prime aged and dependent children populations, the second to the differential growth between the prime aged and elderly groups. Figure 1.5 plots these two terms, showing that virtually all of the improvement in the support ratio in the near term is from a shrinking share of children in the population. Most of the long-run decline in the support ratio is a result of rising numbers of elderly in the period 2010–2035.

Third, the changes in the support ratio between 1990 and 2060 are no larger than, and in some cases significantly smaller than, those that occurred between 1960 and 1990. Using our preferred measures, LF2 and CON2, the support ratio was 14.0% lower in 1970 than 1990. By 2060, it is projected to once again be below the 1990 level, this time by 11.8%. Our support ratio peaks around 1990. One reason why the slow growth of real wages in the U.S. economy since 1973 has been less burdensome than it might have otherwise been is that the labor force participation rate has risen. The figures show clearly that the gains in sustainable consumption from demographic developments are now nearly exhausted.

Finally, while the decline in the support ratio by the middle of the next century is large, there is still substantial uncertainty about the ultimate burden. Figure 1.6 presents support ratios using LF2 and CON2, under the three Social Security Administration demographic forecasts. There are



Figure 1.6: Percentage Change in Support Ratio,  
Alternative Demographic Assumptions  
(Relative to 1990)



Note: The Figure shows the Support Ratio under three demographic assumptions.  
The calculations use LF2 and CON2 as labor force and needs.

substantial differences between the scenarios, particularly between the more pessimistic Case III scenario and the Case IIb scenario which is our standard case. The decline in the support ratio is almost twice as large in the pessimistic scenario as in our benchmark. Even in the optimistic Case I scenario, the support ratio still declines by almost eight percent between 1990 and 2060.

## 2. Capital Accumulation and Shifting Dependency Burdens

This section explores how the demographic shifts described above affect the economy's sustainable level of consumption, and how society should plan for these changes. We find that sustainable consumption increases for the next several decades, and that an economy with otherwise-optimal national saving would reduce its saving in response to the coming demographic changes.

### 2.1 Steady State Consumption Opportunities

Demographic change has two effects on consumption opportunities. First, an increase in dependency lowers output per person, thus reducing consumption per capita. Second, slower labor force growth reduces investment requirements, thus reducing the need for saving and increasing consumption per capita.

To examine the importance of these two changes for consumption opportunities, we assume that output per worker,  $f(k)$ , is divided between consumption and investment. Maintaining constant capital intensity requires investment of  $n \cdot k$ , where  $n$  is the labor force growth rate<sup>12</sup>,  $k$  is the capital-labor ratio, and for expositional ease, we have assumed away depreciation and technical change.<sup>13</sup> When the labor force and the population are not the same, consumption per capita is only a fraction of output net of investment per worker. This fraction is the ratio of the number of workers to the size of

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<sup>12</sup>A substantial part of the U.S. capital stock is residential capital. The natural steady-state condition for housing requires investment at the rate of population growth, not the rate of labor force growth. In steady state, these two growth rates will coincide.

<sup>13</sup>We incorporate both in our numerical simulations below.

the population, precisely the support ratio ( $\alpha$ ) defined above. The resulting equation for per capita consumption is:

$$(2.1) \quad c = \alpha[f(k) - k*n].$$

This expression can be rewritten to find the change in steady-state consumption for changes in  $\alpha$  and  $n$ :

$$(2.2) \quad \Delta c/c = \Delta \alpha/\alpha - [\alpha*(k/c)*\Delta n + (k/c)*\Delta \alpha*\Delta n]$$

with  $c$ ,  $k$ , and  $\alpha$  evaluated at the initial steady state.<sup>14</sup> Equation (2.2) illustrates the two steady-state effects of demographic change. A decline in the labor force-to-population ratio ( $\alpha$ ) reduces the level of per capita consumption which is feasible given the economy's capital stock. At the same time, a decline in the growth rate of the labor force ( $n$ ) permits more consumption for a given capital-output ratio. Society receives a consumption dividend when it is able to invest less and still maintain a given level of per capita output. This "Solow effect" offsets the long run dependency effect on per capita consumption.

Table 2.1 reports the magnitude of these two effects. For each year, we show the steady-state consumption change associated with changes in  $\alpha$  (the first column),  $n$  (the second column), and the combined effect (the third column). The components due to the dependency increase are the same as those in Section 1; the other columns show the extent to which changing investment needs offset this effect.

Two results emerge from Table 2.1. First, the consumption benefits from reduced investment requirements are substantial. During the next two decades,

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<sup>14</sup>We have arbitrarily assigned the second-order term to the second effect in our decomposition. We have also assumed that the capital-labor ratio, and thus the capital-consumption ratio do not change with demographic change. The model we present below justifies this assumption.

Table 2.1: Shifting Steady-State Per Capita Consumption

Needs: Year	Total Population			Equivalence Scale		
	Effect of Dependency	Effect of Labor Force Growth	Total Change in per capita Consumption	Effect of Dependency	Effect of Labor Force Growth	Total Change in per capita Consumption
A. Population 20-64 as Effective Labor Force						
1960	-10.9%	0.4%	-10.6%	-7.4%	0.4%	-7.1%
1970	-10.8	-1.8	-12.6	-7.7	-1.8	-9.5
1980	-3.3	-2.4	-5.7	-2.0	-2.4	-4.5
1990	0.0	0.0	0.0	0.0	0.0	0.0
2000	1.3	0.0	1.3	0.8	0.0	0.8
2010	3.8	1.0	4.8	2.3	1.0	3.4
2020	-0.5	3.0	2.5	-3.1	2.9	-0.2
2030	-5.9	2.5	-3.4	-9.5	2.4	-7.1
2040	-6.2	1.8	-4.3	-10.0	1.8	-8.3
2050	-6.5	2.5	-4.0	-10.4	2.4	-8.0
2060	-7.4	2.1	-5.3	-11.5	2.0	-9.4
2065	-7.4%	2.2%	-5.2%	-11.5%	2.1%	-9.4%
B. Earnings-Weighted Effective Labor Force						
1960	-16.5%	1.1%	-15.4%	-13.2%	1.2%	-12.1%
1970	-16.9	-0.4	-17.3	-14.0	-0.4	-14.4
1980	-7.0	-1.9	-9.0	-5.8	-2.0	-7.8
1990	0.0	0.0	0.0	0.0	0.0	0.0
2000	3.7	2.2	5.9	3.2	2.2	5.4
2010	2.8	3.5	6.3	1.4	3.5	4.9
2020	-2.3	4.4	2.1	-4.8	4.2	-0.6
2030	-6.0	3.7	-2.3	-9.6	3.6	-6.0
2040	-6.6	3.6	-3.0	-10.5	3.5	-7.0
2050	-7.3	3.9	-3.5	-11.2	3.7	-7.5
2060	-7.7	3.6	-4.1	-11.8	3.5	-8.3
2065	-7.8%	3.7%	-4.2%	-12.0%	3.5%	-8.4%

Note: The table shows the steady state change in consumption relative to the 1990 base if demographic change were to reach a steady state at its level of the indicated year. Panel A shows the results using the population 20-64 (LF1) as the effective labor force. Panel B shows the results using earnings-weighted workers (LF2) as the effective labor force.

the benefits of slower labor force growth will be about 1 to 3.5 percent of per capita consumption, using the 1990 base. Since the labor force was growing more rapidly in the 1970s and 1980s than in 1990, the effect of reduced investment requirements is even larger relative to earlier years. By the middle of the next century, the benefits of slower labor force growth will be between 2.1 and 3.7 percent of per capita consumption. This is between one-quarter and one-half of the adverse dependency effects of the changing population mix.

Second, while the investment effect offsets a substantial part of the long term dependency increase, it magnifies the short run effect of rising support ratios. Reduced dependency and slowing labor force growth both increase consumption possibilities so that by 2010, society will be between 3 and 6% richer, depending on the combination of labor force and needs measures. Only after 2020 does the increase in dependency outweigh the decline in investment needs and reduce consumption below its 1990 level.

The steady state consumption decline between 1990 and 2060 is estimated at between 4% (with effective consumers set equal to total population) and 9% (with effective consumers computed using equivalence scales). As with the support ratios, this finding is more sensitive to our definition of consumption needs than to our choice regarding the definition of the effective labor force. For almost all cases, however, society is richer in the new steady state than in 1970 or 1980.

## 2.2 Demographic Change and Optimal Capital Accumulation

The results presented so far suggest that in the short run, demographic changes will raise the level of consumption that can be sustained while

maintaining the level of capital intensity. In the long run, they will reduce the sustainable level of consumption. The question then becomes how society should adjust its saving policy to these developments. In order to study this question, we use the standard Ramsey optimal growth model.

We assume that a social planner seeks to maximize

$$(2.3) \quad V = \int_0^{\infty} e^{-\rho t} P(t) U(c_t) dt$$

where  $P(t)$  denotes the number of individuals alive in period  $t$ ,  $c(t)$  is per capita consumption, and  $\rho$  is the social time preference rate. We denote the current period as time zero. This social welfare function weights the utility of a representative individual in each generation by the generation's size.<sup>15</sup> In our earlier notation,  $P(t) = N(t)/\alpha_t$  where  $N(t)$  is the labor force and  $\alpha_t$  is the support ratio.

Our analysis abstracts from the overlapping generations structure of the actual population. Calvo and Obstfeld (1988) formally justify this procedure by demonstrating that if age-specific transfer programs like Social Security are available, and if individual utility functions are additively separable, then "the Cass-Koopmans-Ramsey framework can be used to evaluate paths of aggregate consumption in models where different generations co-exist...the planning problem facing the government can be decomposed into two sub-problems: a standard problem of optimal aggregate capital accumulation, and a

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<sup>15</sup>Some might argue for using an alternative objective function which does not weight the average utility of different generations by the number of people in the generation. This will lead the social planner to raise average consumption in small cohorts relative to that in larger cohorts, because the aggregate resource cost of raising the average consumption of persons in small cohorts is less than that for large cohorts. We see no legitimate ethical argument for weighting persons in different sized cohorts differently.

problem of distributing consumption optimally on each date among generations alive then (p. 163)."

The social planner maximizes (2.3) subject to a capital accumulation constraint analogous to equation (2.1):<sup>16</sup>

$$(2.4) \quad \dot{k}_t = f(k_t) - c_t/\alpha_t - k_t * n_t.$$

If  $\alpha_t = 1$ , equation (2.4) reduces to the standard resource constraint in neoclassical growth models. The consumption profile which solves this problem satisfies:

$$(2.5) \quad \dot{c}_t/c_t = \sigma * [f'(k_t) - \rho]$$

where  $\sigma = -U'(c_t)/c_t * U''(c_t)$ , the elasticity of substitution in consumption.

In steady state with no technical progress, per capita consumption and the capital-labor ratio must be constant. From the Euler equation (2.5), we find that constant consumption requires

$$(2.6) \quad k^* = f'^{-1}[\rho].$$

This locus, a vertical line in  $(c, k)$  space, is drawn in Figure 2.1. Constancy of the capital-labor ratio given in equation (2.1) yields the second locus drawn in Figure 2.1.

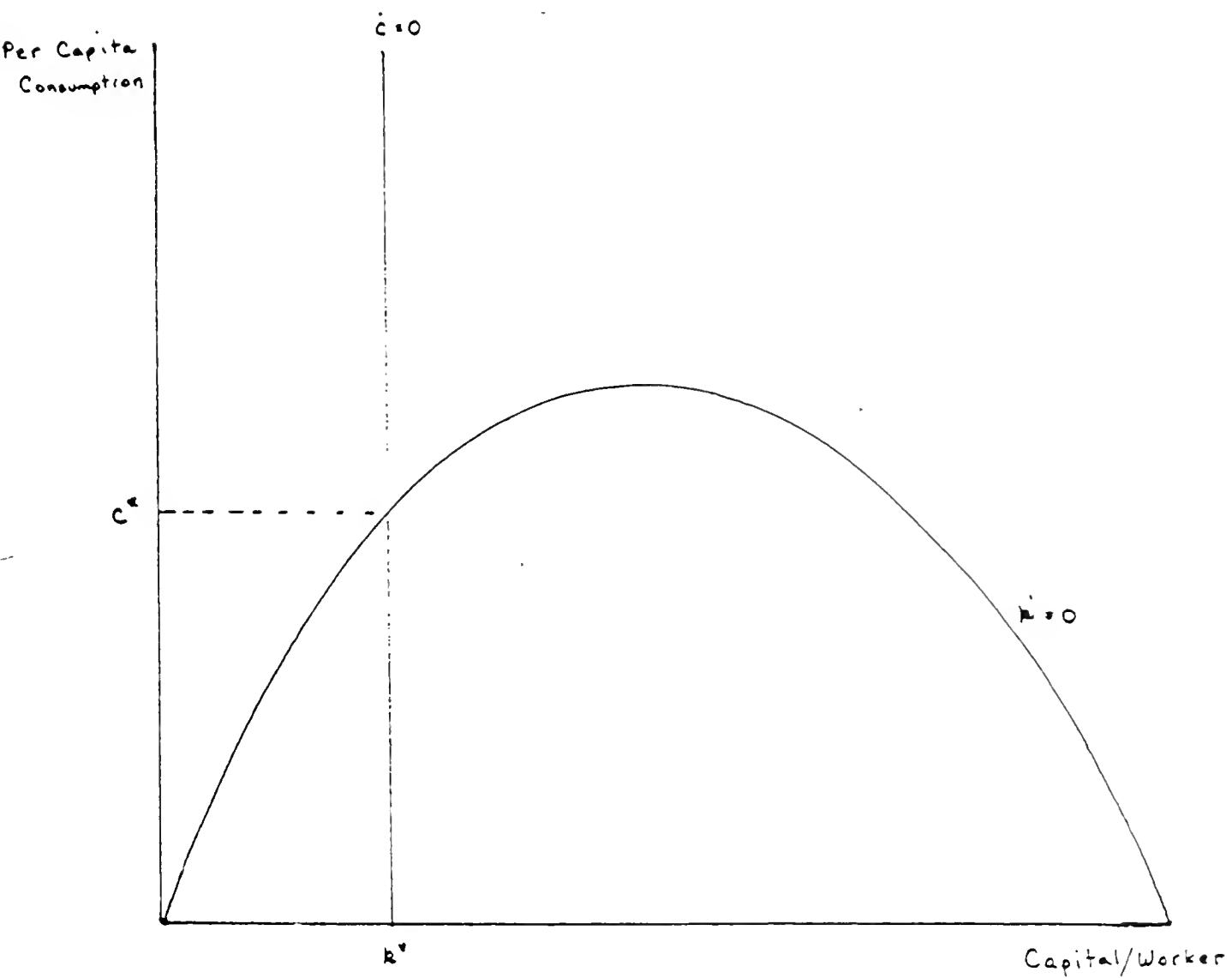
Permanent reductions in  $\alpha$ , the support ratio, scale back the feasible level of per capita consumption for each  $k$ , shifting the  $\dot{k} = 0$  locus as shown in Figure 2.2. The steady-state capital-labor ratio is unaffected by this change, so the only effect of this shock is an immediate and permanent decline in consumption per capita. Reductions in  $n$ , the labor force growth rate, have the opposite effect, shifting the  $\dot{k} = 0$  frontier out. The steady-state consumption effect of a demographic shift such as a fertility decline, which

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<sup>16</sup>The optimal plan must also satisfy transversality conditions noted for example by Blanchard and Fischer (1989).



Figure 2.1: Steady-state Analysis of Optimal Consumption Level



reduces both  $\alpha$  and  $n$ , depends on which of these effects is larger. Reductions in  $n$  unambiguously reduce the optimal steady state saving rate while increases in  $\alpha$  have no effect on steady state savings.<sup>17</sup>

The actual demographic projections for the United States are more complex than an immediate shift in either  $\alpha$  or  $n$ , however. For the next several decades, the net effect of demographic change is an outward shift in the  $\dot{k} = 0$  locus, followed by a period of inward shift which terminates with the locus below its current level. When consumers have perfect foresight and recognize the complex nature of the demographic transition, the initial consumption response to news of the demographic transition is theoretically ambiguous. Figures 2.3a and 2.3b illustrate this. Each presents a scenario in which the  $\dot{k} = 0$  frontier shifts out and then back. In the first case consumption increases when demographic news arrives, while in the second consumption initially declines.

This ambiguity suggests the need for explicit numerical simulations to address the optimal consumption response. We assume that the utility function in (2.3) has the form

$$(2.7) \quad U(c_t) = (c_t^{1-1/\sigma} - 1)/(1-1/\sigma)$$

where  $\sigma$  is the elasticity of substitution in consumption. We also assume a constant elasticity of substitution production function:

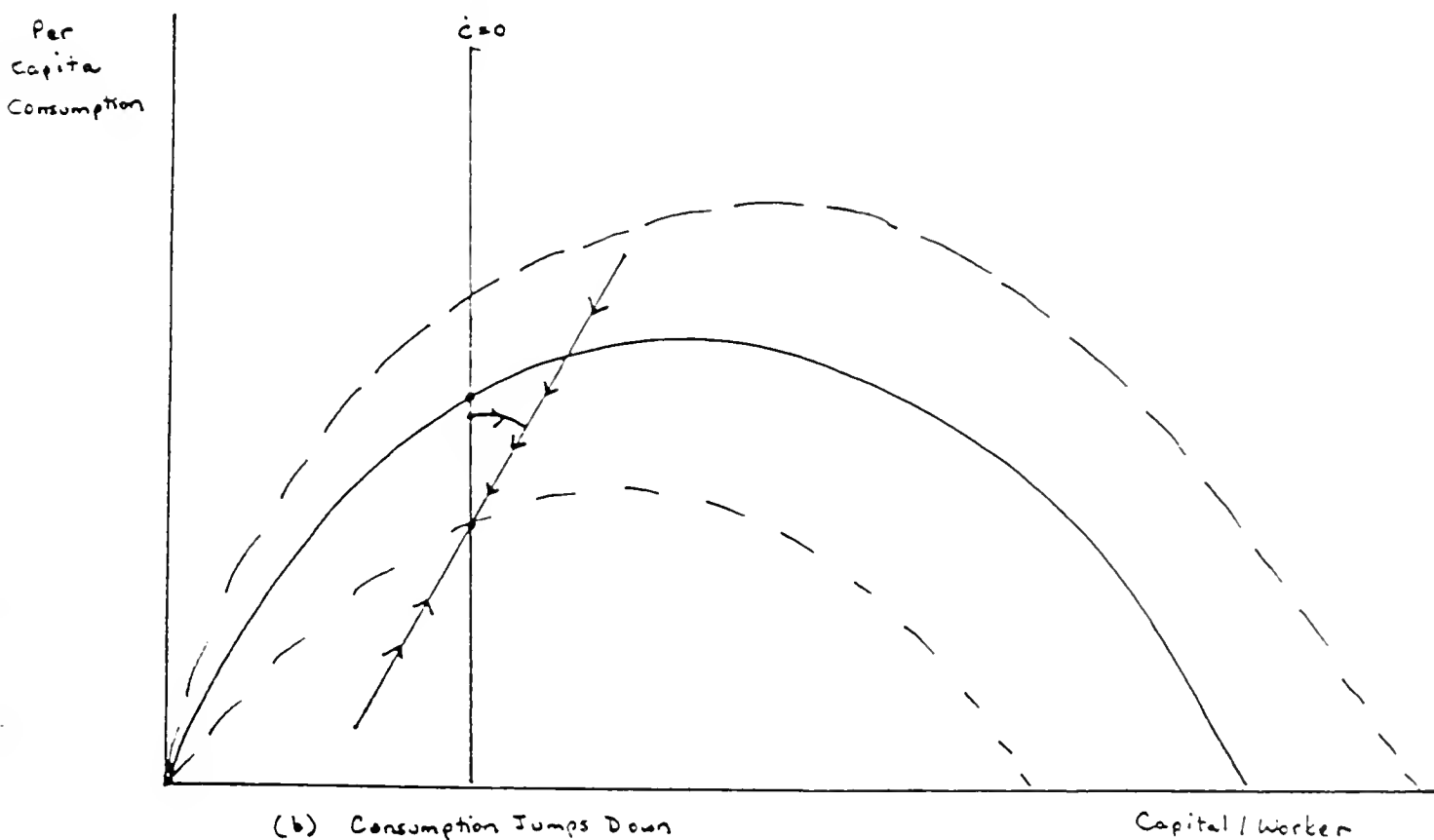
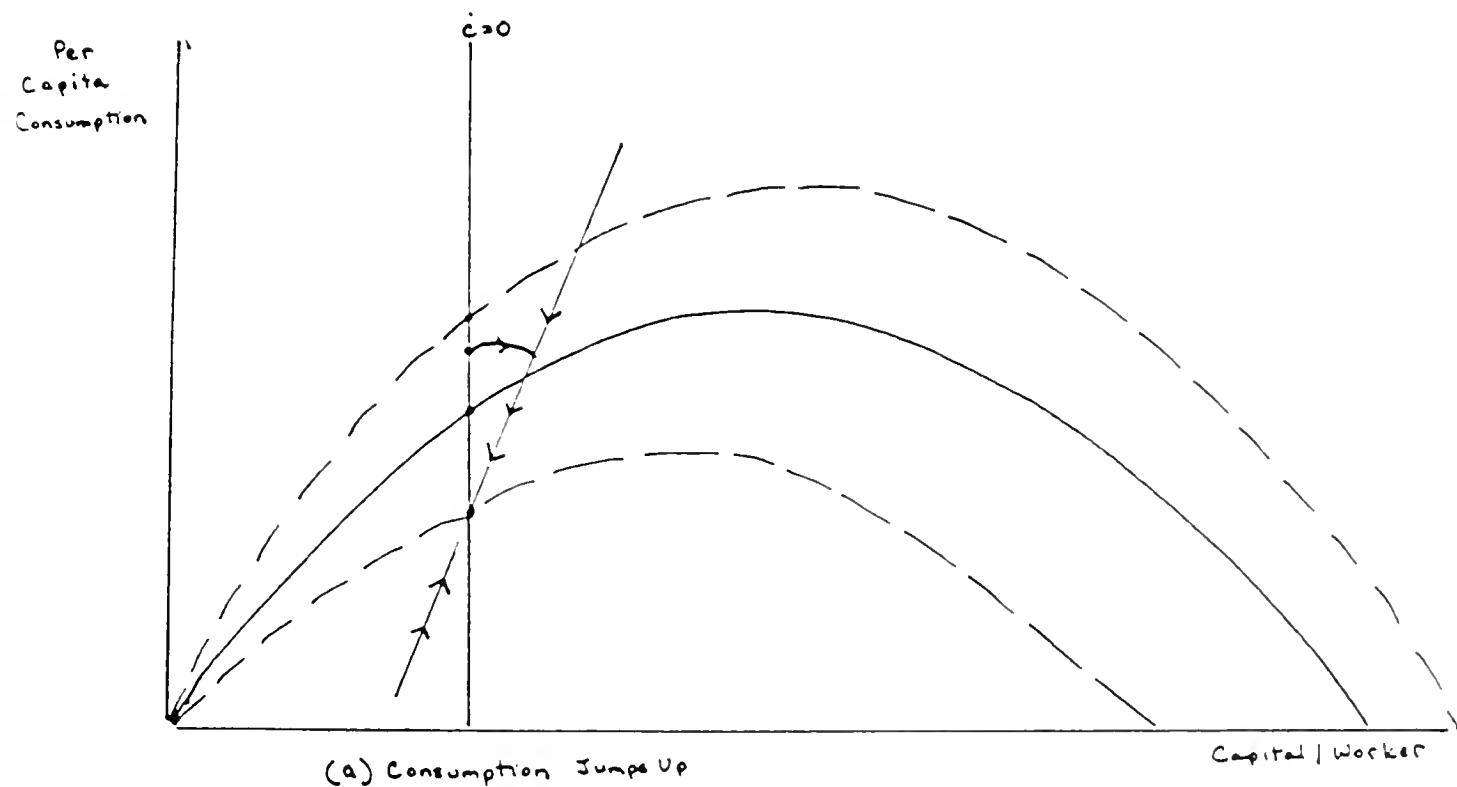
$$(2.8) \quad f(k_t) = [a * k_t^{1/1-\beta} + b]^{1-\beta}.$$

The elasticity of substitution in production is  $\beta$ . To find the transition path between one steady state and another, we discretize differential equations

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<sup>17</sup>This is easily seen from the Harrod-Domar condition  $k/f(k) = s/n$ , where  $s$  is the saving rate out of national income, and the observation that neither changes in  $\alpha$  nor changes in  $n$  affect optimal steady state capital intensity in the Ramsey model.

Figure 2.3: Optimal Consumption Response to a Fertility Decline



(2.4) and (2.5) and employ a grid-search algorithm to find the initial consumption level which will lead the economy to the new steady state.<sup>18</sup>

Our simulations also allow for labor augmenting technical change ( $g$ ) and depreciation ( $\delta$ ), which are introduced into equations (2.4) and (2.5) in the standard way<sup>19</sup>. Although consumption grows over time when there is technical progress, the consumption numbers we report are relative to the consumption that would have been possible without demographic change. We assume that technical change is equal to 1.4 percent per year, the Social Security Administration's steady-state projection.<sup>20</sup> The depreciation rate is set equal to 4.09 percent, the US average from 1952–1987.<sup>21</sup> Finally, we use data for this period on payments to labor and capital to estimate capital's share in gross output—33.2 percent.<sup>22</sup> These two numbers imply a steady state marginal product of capital of 14.4 percent. From equation (2.5), this implies an effective discount rate ( $\rho + \sigma * g$ ) of 10.3 percent.

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<sup>18</sup>Since the Social Security Administration only forecasts population in every fifth year, we interpolate annual observations using a smooth interpolator. The results are not sensitive to the frequency of the data.

<sup>19</sup>Following Blanchard and Fischer (1989), we express capital per "effective worker", where effective workers grow at  $n+g$ . Consumption is expressed per "effective person". In equation (2.5), the effective discount rate becomes  $(\rho + \delta + g * \sigma)$ .

<sup>20</sup>Our results are insensitive to the choice of  $g$ .

<sup>21</sup>Our depreciation rate is estimated as capital consumption allowances divided by the aggregate capital stock. We define aggregate capital as national assets minus consumer durables minus one half of the value of land. Consumer durables are excluded since they are not included in output. One half of land is included in capital to allow for natural resource values to change.

<sup>22</sup>Capital's share in output is total output less wages and salaries, two-thirds of proprietors income (the estimated labor compensation) and indirect business taxes, divided by output less indirect business taxes.

We present results using two values of  $\sigma$ , a benchmark case of unit elasticity ( $\sigma=1$ ) and an alternative elasticity of substitution of one-tenth ( $\sigma=.1$ ). We also choose two values for the elasticity of substitution in production, a benchmark of unit elasticity ( $\beta=1$ ) and an alternative elasticity of one-half ( $\beta=.5$ ). When the elasticity of substitution in consumption is low, consumption today is not a good substitute for consumption tomorrow, and we expect more consumption smoothing. When the elasticity of substitution in production is low, saving does not get a high return since the extra capital does not substitute well for the smaller labor force, and we expect less consumption smoothing.

Demographic change has occurred gradually over the last 25 years, as the baby boom has given way to the baby bust. It is not obvious how best to model these changes as a single shock. Initially, we assume the economy is in steady state with values of  $\alpha$  and  $n$  corresponding to those prevailing in 1990, and ask how consumption and saving should evolve henceforth. Since some of the consequences of demographic change were already known by 1990, we go on to examine how consumption and saving should have responded in 1970 and 1980 if news of demographic change suddenly arrived.

For all our simulations, we use the trajectories of  $\alpha$  and  $n$  implied by the Social Security Administration's IIB forecasts, and further assume that the predicted values for 2065 persist as the economy's final steady state. The resulting consumption changes are thus the optimal response to the demographic transition which the U.S. will undergo over the next seven decades, assuming these changes were unforeseen as of 1990.

The results of these simulations are shown in Table 2.2. The level of per capita consumption in the 1990 steady state is normalized to 100. The

Table 2.2: Optimal Consumption Response to Demographic Shocks

Substitution Elasticity in Production:	1.0	1.0	0.5	0.5	
Substitution Elasticity in Consumption:	1.0	0.1	1.0	0.1	
Expectations:	Static	Perfect Foresight			
<hr/>					
<u>Case 1: Labor Force=Population 20-64; Effective Consumers=Total Population</u>					
Initial Steady State	100.0	100.0	100.0	100.0	100.0
Adjustment	100.0	100.6	101.1	100.4	101.0
Time Path					
2000	101.3	101.4	101.3	101.4	101.3
2010	104.8	103.3	101.7	103.8	102.1
2020	102.5	102.3	101.4	102.5	101.7
2030	96.6	98.3	100.3	97.7	99.8
2040	95.7	96.2	99.0	95.9	98.1
2050	96.0	95.9	98.1	95.9	97.1
2060	94.7	95.1	97.3	95.0	96.2
New Steady State	94.8	94.8	94.8	94.8	94.8
 <u>Case 2: Labor Force=Earnings-Weighted; Effective Consumers=Equivalence Scale</u>					
Initial Steady State	100.0	100.0	100.0	100.0	100.0
Initial Adjustment	100.0	102.3	102.8	101.9	102.8
Time Path					
2000	105.4	104.1	103.0	104.5	103.3
2010	104.9	104.1	102.8	104.5	103.0
2020	99.4	100.4	101.5	100.2	101.1
2030	94.0	95.7	99.6	95.0	98.3
2040	93.0	93.5	97.8	93.2	96.0
2050	92.5	92.7	96.3	92.6	94.5
2060	91.7	92.0	95.1	91.8	93.4
New Steady State	91.6	91.6	91.6	91.6	91.6

Note: Each column is the simulated path of consumption in response to a demographic shock like that which the U.S. will experience between 1990 and 2060. The static expectations column is the change in consumption assuming that agents in each period assume that the current level of  $\alpha$  and  $n$  will persist forever. The "perfect foresight" columns assume current knowledge of the entire path of demographic change. The initial steady state is the 1990 value of  $\alpha$  and  $n$ .

first column in Table 2.2, the static expectations response, is the change in consumption if consumers have no foresight about demographic change, but rather assume at each date that current conditions will persist forever. It thus corresponds to the consumption path in Table 2.1. The other four columns assume that consumers in 1990 have perfect foresight regarding future demographic changes.

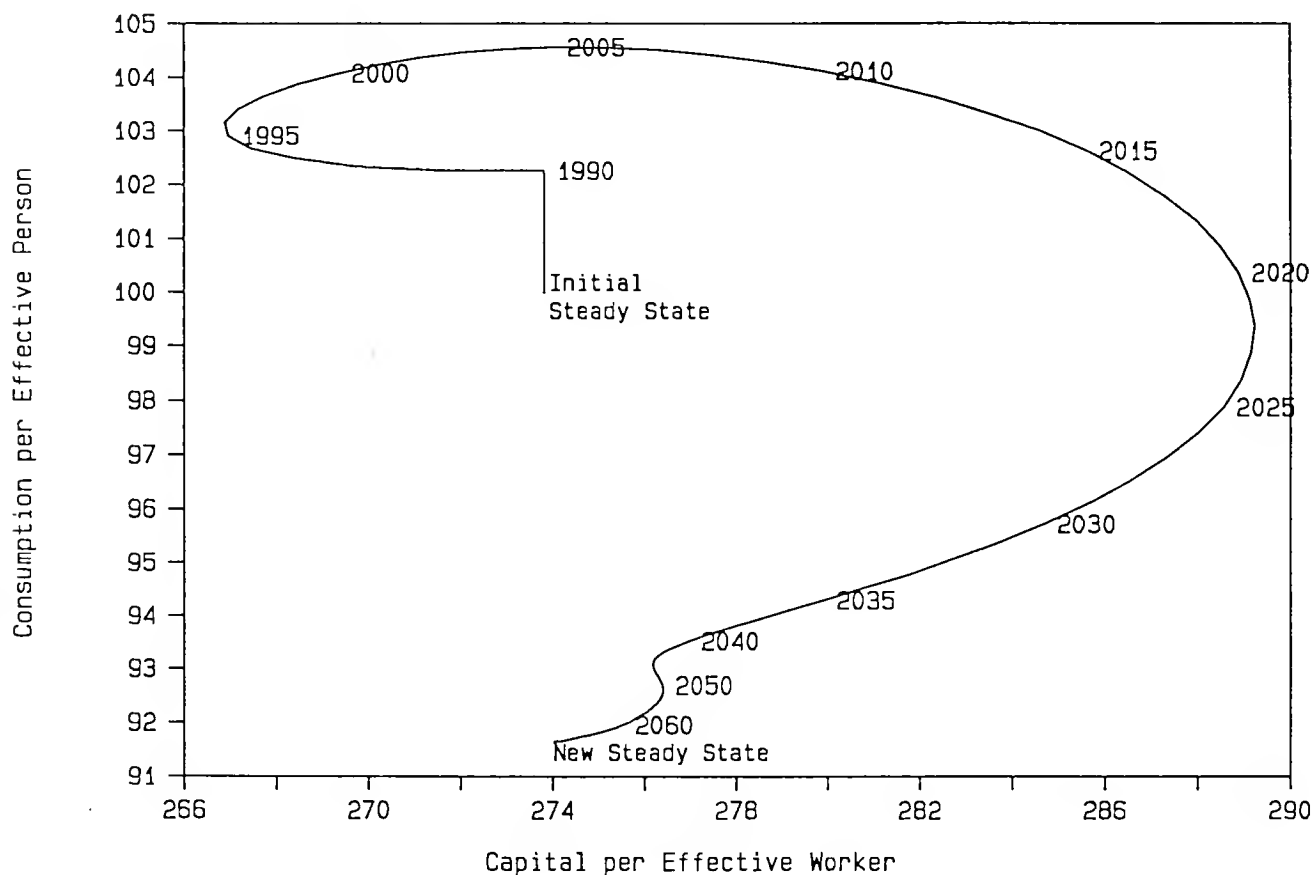
For all of the parameter values, consumption rises initially in response to the demographic transition, by up to 2.2 percent relative to the steady state implied by 1990 demography. This result is insensitive to the parameter choices we present.<sup>23</sup> Consumption remains above its 1990 level until 2020 or later. Thus, demographic shifts during the next half century optimally raise present consumption. The effect is more pronounced when consumption is less substitutable over time and less pronounced when production is less substitutable over time.

Figure 2.4 shows the movements of consumption and capital for the simulations using the Case 2 assumptions and the unit elasticities of substitution in production and consumption are shown in Figure 2.4. The corresponding saving rate is shown in Figure 2.5. Consumption initially rises by 2.3 percent. This is followed by a period of declining capital-labor ratios, during which consumption continues to increase. The shifting opportunity locus due to the decline in labor force growth ultimately causes an increase in saving and thus in capital intensity, even at the higher level of consumption. After the period of capital deepening, consumption begins to

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<sup>23</sup>In addition to the parameter values reported, we have experimented with elasticities in substitution and production up to 10. For none of these cases is there an initial increase in savings.

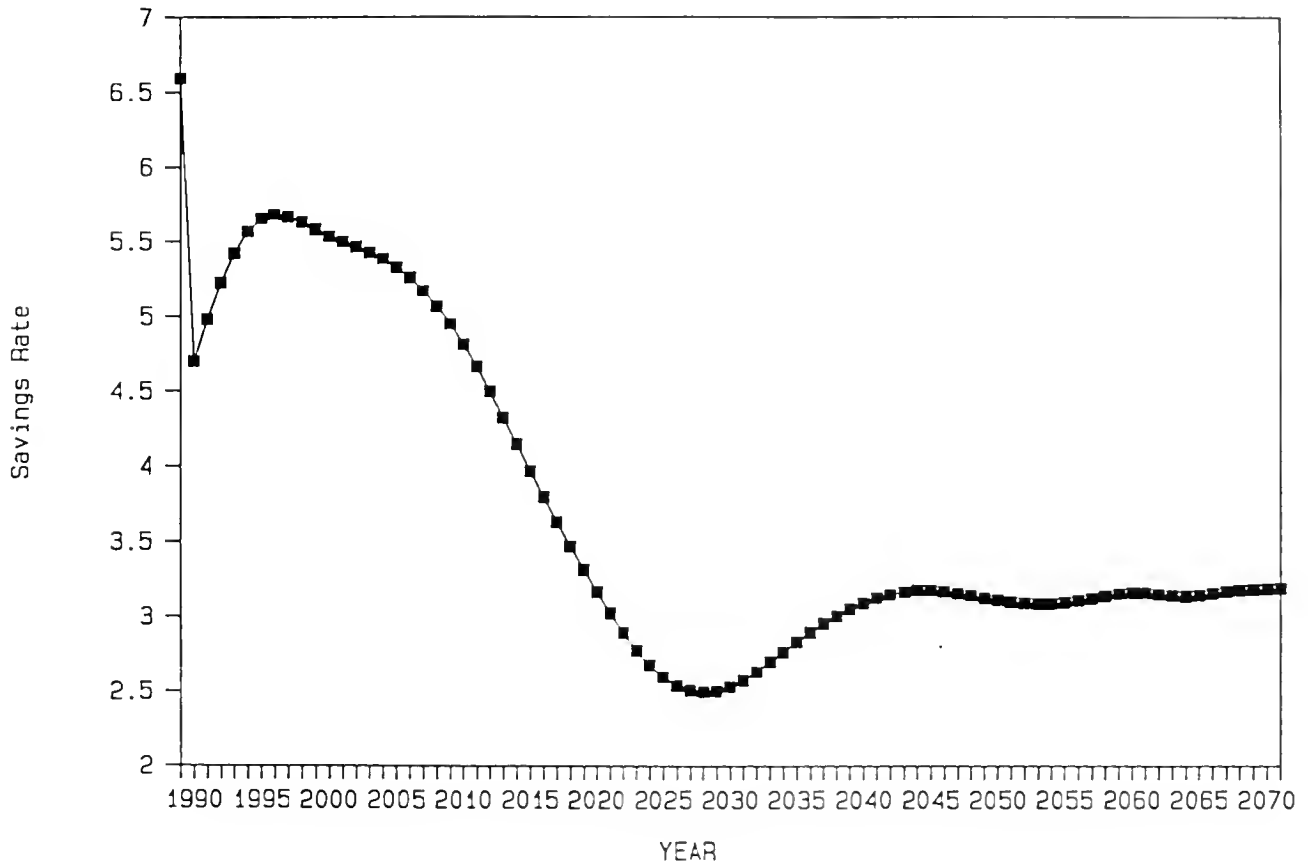
Figure 2.4: Optimal Consumption and Capital-Labor Paths Following Demographic Change



Note: The Figure shows the trajectory of consumption per effective person and capital per effective worker for the simulation using the LF2 and CON2 measures of labor force and needs.



Figure 2.5: Optimal Saving Rates  
in Response to Demographic Change



Note: The Figure shows the optimal saving path for the simulation  
using the LF2 and CON2 measures of labor force and needs.

decline. Finally, when the increase in dependency overtakes the favorable effects of the slowing labor force growth, both consumption and capital decline to the new steady state, and saving falls.

As Figure 2.5 demonstrates, the saving rate initially falls by almost 2 percentage points. The saving rate then increases for a few years, though it never attains its initial steady state value. This increase is due to the increase in the support ratio, which allows both consumption per person and the saving rate to increase. Finally, the saving rate begins to fall towards its new long run level, equal to the amount of saving necessary to equip the more slowly growing labor force.

We also ran the simulations using the Case I and Case III Social Security alternatives, with no substantive changes in results. Consumption rises less with the Case I assumptions than with our benchmark Case IIb assumptions, since the number of dependent children does not decrease as quickly, and more with the Case III assumptions, where there is an even larger short run benefit. In all three cases the response to the demographic news is a decrease in saving. We have also experimented with changing capital's share or the assumed initial level of capital intensity in order to vary the discount rate  $\rho$ .<sup>24</sup> Even with a pure discount rate as low as zero, our conclusion that consumption rises following a demographic shock remains valid.

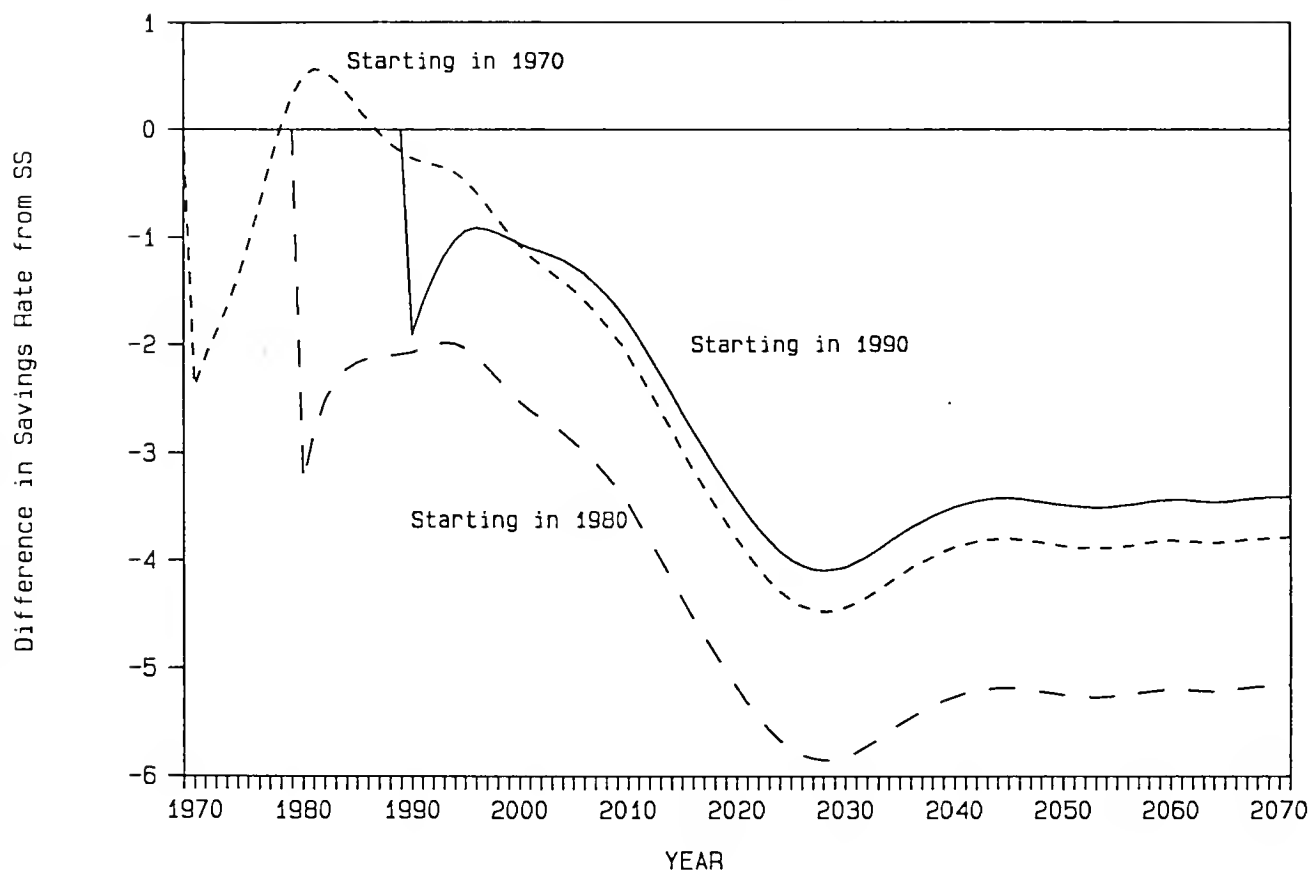
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<sup>24</sup>Since the effective discount rate must equal the marginal product of capital in steady state, and the marginal product of capital is the ratio of capital's share in output to the capital-output ratio, changes in the effective discount rate have to be accompanied by changes in either capital's share or the capital-output ratio.

Finally, we explored how consumption would change if we began the simulations in 1970 or 1980. As Table 2.1 demonstrated, consumption possibilities are higher in 1990 than in any of the three previous decades. Figure 2.6 shows the deviation of the saving rate from its initial steady state level after the demographic news. In all of the simulations, saving falls immediately following the demographic news, and is always falling by 2000. Even in the cases where saving begins to increase in the 1990's — when we begin the simulation in 1980 or 1990 — the saving rate is lower throughout the 1990's than the original steady state, and it begins a period of prolonged decline by 2000. While these figures help to develop perspective on the recent decline in U.S. saving and investment rates, the actual decline in U.S. national saving from an average of 7.1 percent in the 1970s to about 2 percent in the late 1980s is considerably more than our demographic analysis can justify.

The analysis in this section reaches a clear conclusion. For an economy choosing its consumption path in accord with a standard optimal growth model, the right response to the upcoming U.S. demographic change would be an increase in consumption and a reduction in national saving. For all plausible combinations of parameter values, the effects of reduced labor force growth and reductions in the number of children exceed the effects of increases in long run dependency.

Figure 2.6: Change in Saving Rates  
in Response to Demographic Change,  
Using Different Beginning Dates



Note: The Figure shows the percentage point difference in saving rates from the initial steady state following a demographic change. All three simulations use the LF2 and CON2 measures of labor force and needs.

### 3. Open Economy Aspects of the Demographic Shift

Our analysis thus far has focused on the demographic change in the United States. When capital markets are integrated, however, the demographic shift in the U.S. must be measured not only in absolute terms but relative to the coincident shifts in our major trading partners. This section compares the degree of population aging in different nations, and extends our earlier simulation model to consider the U.S. in relation to other OECD countries. Our earlier finding that, ceteris paribus, demographic changes justify a reduction in optimal saving is reinforced when we allow for international capital flows, since demographic change is less pronounced in the U.S. than elsewhere in the OECD.

#### 3.1 Relative Rates of Population Aging

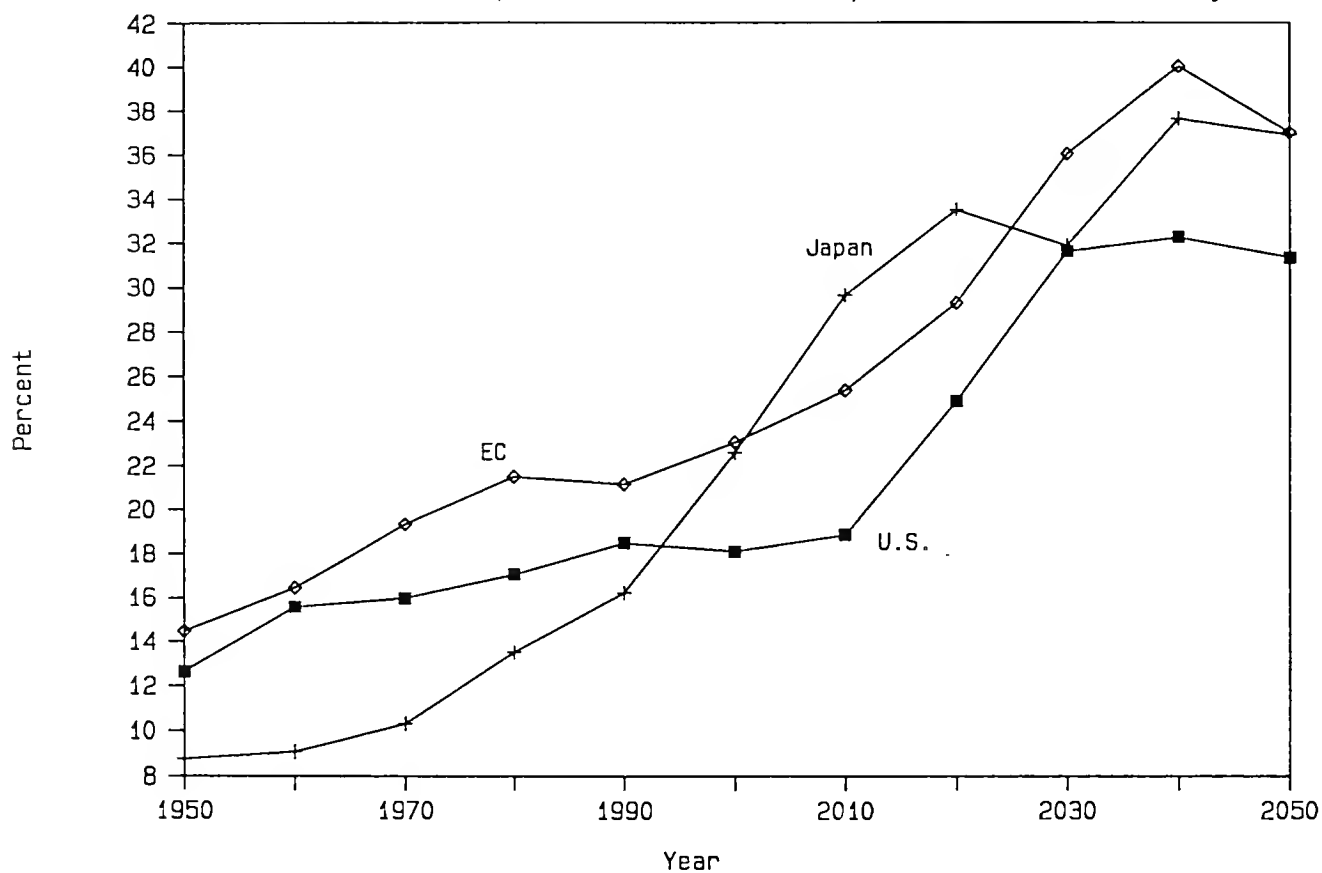
To compare rates of population aging, we use projections by the OECD (1988). These projections differ in two important ways from the Social Security Administration projections used above for the U.S. First, the OECD treats the 15-19 age group as workers rather than dependents. Second, and more important, the OECD assumes that fertility rates in all countries will converge to the replacement level of 2.1 by 2050. Since U.S. fertility rates are currently well above those in most of the OECD, this understates the likely contrast between the future U.S. and foreign demographic experiences.

Figure 3.1 shows the historical and projected elderly dependency ratio for the U.S., Japan, and the European Community.<sup>25</sup> The elderly dependency ratio increases substantially in all countries, with the most rapid increase

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<sup>25</sup>The multi-country index is a GDP-weighted average of the indices for the individual countries.

Figure 3.1: Elderly Dependency Ratios, 1950-2050,  
U.S., Japan, and European Community



Note: The Figure shows the ratio of the elderly population to the population 15-64.

Source: OECD (1988).

in Japan. By 2050, even with a 19 percentage point increase in the elderly dependency ratio, the United States' ratio will be roughly 5 percentage points lower than in the other countries.

Figure 3.2 shows the path of the support ratio corresponding to the LFI and CON1 assumptions earlier. The broad outlines for all three regions are similar. All have higher support ratios in 1990 than in 1960, and all will have much lower support ratios by the middle of the next century than they do today. The ultimate level of United States dependency will be lower than that abroad.

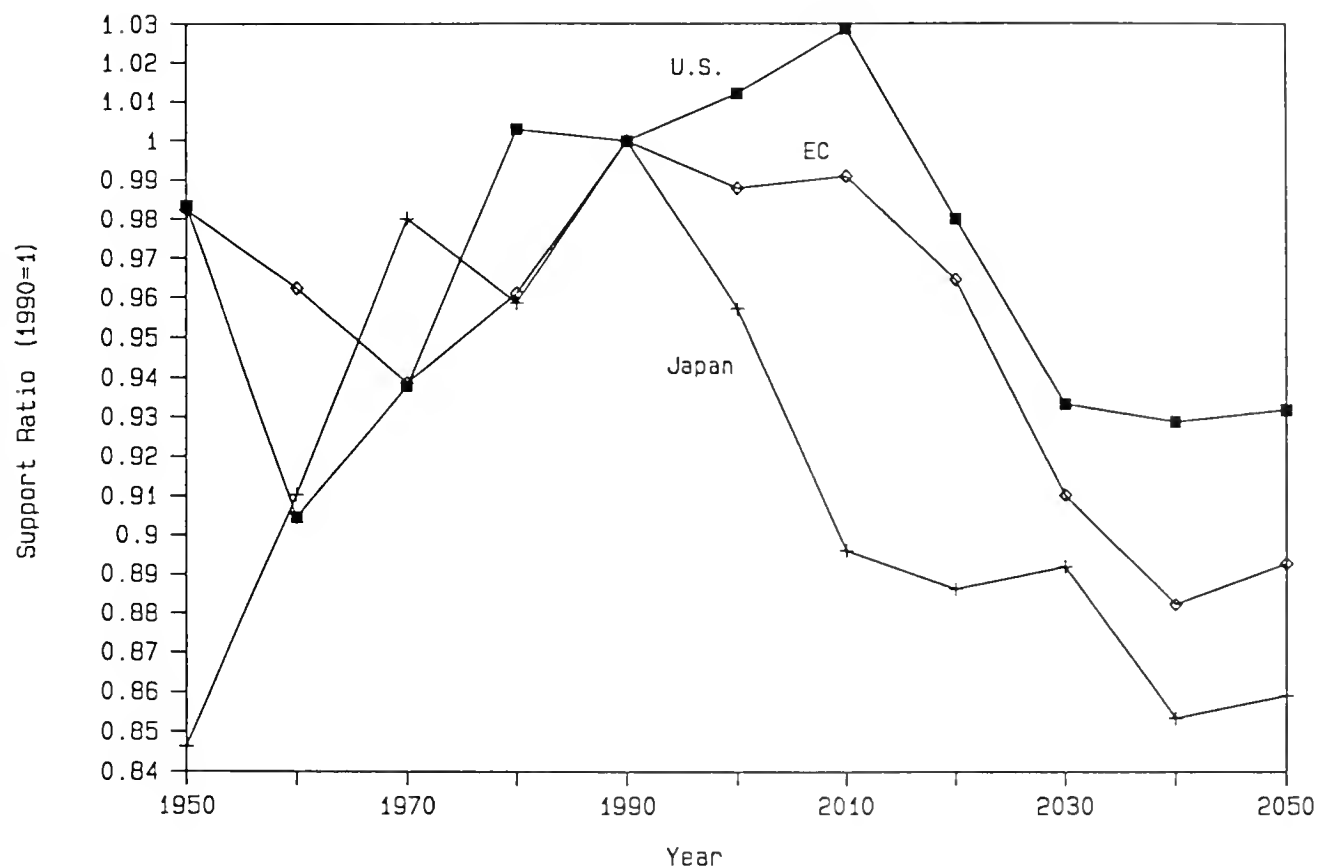
Two differences in these indices are notable, however. First, the United States will be better off for the next two decades than it is now, while the other countries experience declines in the support ratio beginning in 1990. Second, the U.S. and EC dependency ratios are driven principally by fertility changes, while the Japanese changes are driven to a much larger extent by reductions in mortality. The decline in the support ratio in the 1950s in the United States and in the 1960's in the EC is due to increased numbers of children; the rise in the support ratio throughout the post-war period in Japan, in contrast, is caused by reduced mortality at middle and older ages. Since the labor force grows faster when fertility is higher, the reduction in labor force growth over the next several decades, and thus the consumption dividend from reduced investment requirements, will be larger in the U.S. and the European Community than in Japan.

To evaluate the size of the demographic transition abroad, Table 3.1 reports the optimal consumption and saving responses to projected demographic changes in Japan, the European Community, the non-U.S. OECD, and the total





Figure 3.2: Support Ratios, 1950-2050,  
U.S., Japan, and European Community



Note: The Figure uses the LF1 and CON1 measures of labor force and needs.

Table 3.1: Autarky Response of Consumption and Saving to Demographic Shocks

	Country				
	US	Japan	European Community	Non-US OECD	Total OECD
A. Consumption Response					
Initial Steady State	100.0	100.0	100.0	100.0	100.0
Adjustment	100.1	99.2	100.1	100.0	100.1
Time Path					
2000	100.6	97.2	99.7	99.3	99.8
2010	101.5	92.2	98.8	97.8	99.2
2020	99.1	89.0	97.1	95.5	97.0
2030	94.4	88.5	92.8	92.1	93.0
2040	92.0	86.3	89.1	88.8	89.9
2050	92.1	84.8	88.2	87.9	89.1
New Steady State	92.3	84.4	87.9	87.8	89.0
B. Saving Rate Response					
Adjustment	-0.10	0.72	-0.12	0.02	-0.04
Time Path					
2000	0.14	-1.36	-0.88	-0.95	-0.60
2010	0.47	-3.03	-0.69	-1.14	-0.52
2020	-1.44	-2.63	-1.46	-1.80	-1.58
2030	-2.44	-1.30	-2.76	-2.51	-2.54
2040	-1.51	-3.08	-2.89	-2.90	-2.30
2050	-1.36	-1.48	-0.84	-1.20	-1.32
New Steady State	-1.51	-1.28	-0.69	-1.09	-1.25

Note: The values in the table are the optimal consumption and saving paths for each country without international capital flows. We use the equivalence scale for consumption needs. Consumption is relative to the initial steady state, which is assumed to be 100. Savings paths are defined as the percentage point difference between the saving rate along the path and the initial steady state. The elasticities of substitution in production and consumption equal unity.

OECD.<sup>26</sup> These consumption paths are simulated using the model of the last section. For the United States, consumption rises only slightly initially, continues increasing until 2010, and then declines to the new steady state. This consumption increase is accompanied by an increased saving rate, however, since the relative increase in the working age population increases output per person by more than consumption per person.

For Japan, the coming demographic changes reduce optimal consumption initially by just under 1 percent, and consumption continues to decline throughout the next 60 years, even as the saving rate declines. For the European Community, there is also a slight increase in consumption, but by 2000 consumption is lower, and continues to decline throughout the next half century. This pattern of declining consumption after a small increase in initial consumption carries over to the non-U.S. OECD and total OECD simulations.

The initial decrease in the saving rate in the United States, and the increase in the non-U.S. OECD implies that in an open economy capital would initially flow from the non-U.S. OECD to the United States. After the initial change in saving, however, capital flows are more difficult to predict. In addition to the change in saving rates in the autarky case, the countries also have different changes in labor force growth rates and thus investment requirements. Since the desired capital inflow depends on the difference

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<sup>26</sup>The table uses the case of unit elasticities of substitution and production. We assume that depreciation rates and rates of labor augmenting technical progress are equal in all countries and are the same as the Social Security Administration forecasts for the U.S.. The assumption of equal productivity growth is obviously wrong but probably does not have a large impact on estimates of the change in saving due to changes in demographic structure.

between saving and investment requirements, looking at saving rates or consumption alone does not indicate whether each country group would borrow or lend. To address this issue, we turn next to simulations that allow for capital mobility.

### 3.2 A Two-Country Simulation Model

Our open economy simulations aggregate the European Community, Japan, and the other countries of the OECD to form a non-U.S. OECD index. Figures 3.3a and 3.3b show the support ratio and labor force growth rates for this aggregate.<sup>27</sup> The support ratios are consistent with those in Figure 3.2. The United States has a five percent higher support ratio in 2050 than the other countries in the OECD, and unlike the rest of the OECD has a rising support ratio over the next two decades. For both the U.S. and non-U.S. OECD, the long run change in labor force growth is about the same, although the non-U.S. OECD has a more immediate decline in labor force growth.

To assess the optimal response of U.S. saving in an open economy context, we extend the model of the previous section to allow for capital mobility. We distinguish asset ownership from asset location, denoting period  $t$  asset ownership per person in country 1 by  $a_{1,t}$ . Asset accumulation is given by

$$(3.1) \quad \dot{a}_{1,t} = w_t + a_{1,t}*(r_t - n_{1,t}) - (c_{1,t}/\alpha_{1,t})$$

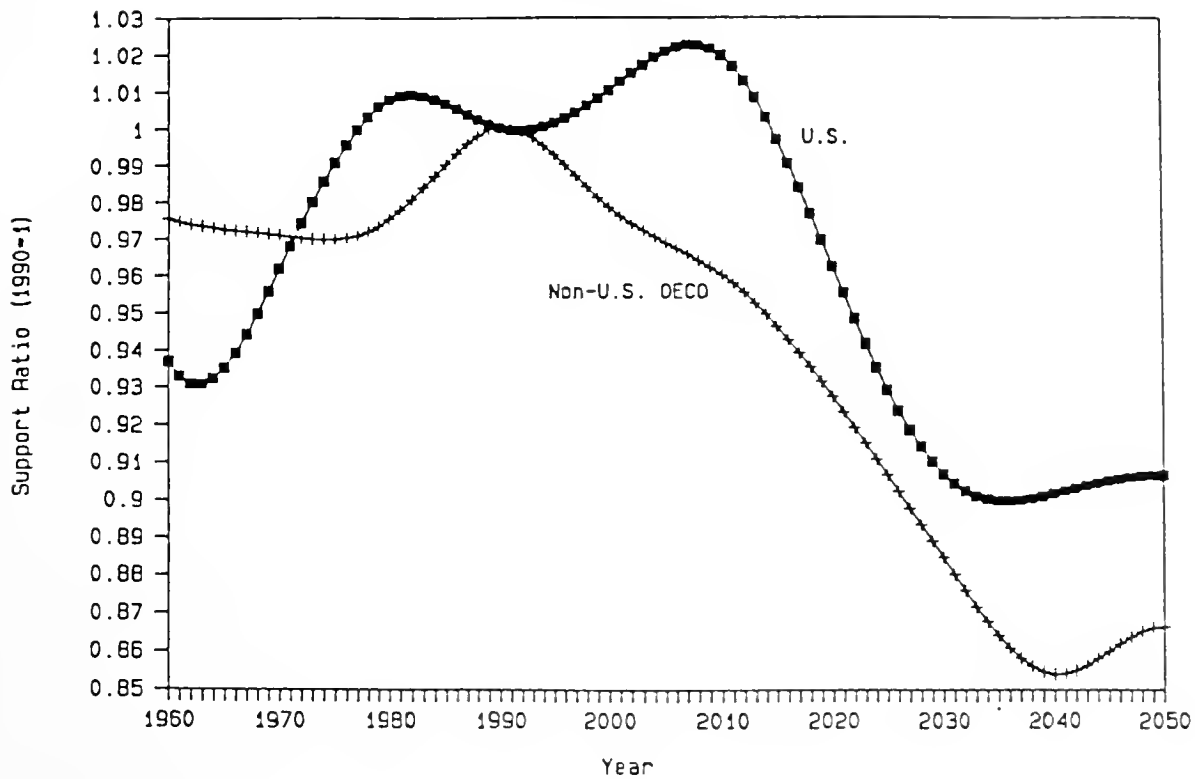
where the wage,  $w_t$ , and the interest rate,  $r_t$ , are equalized across countries. The labor force growth rate, the support ratio, and the level of per capita consumption can differ across countries and therefore have both time and country subscripts.

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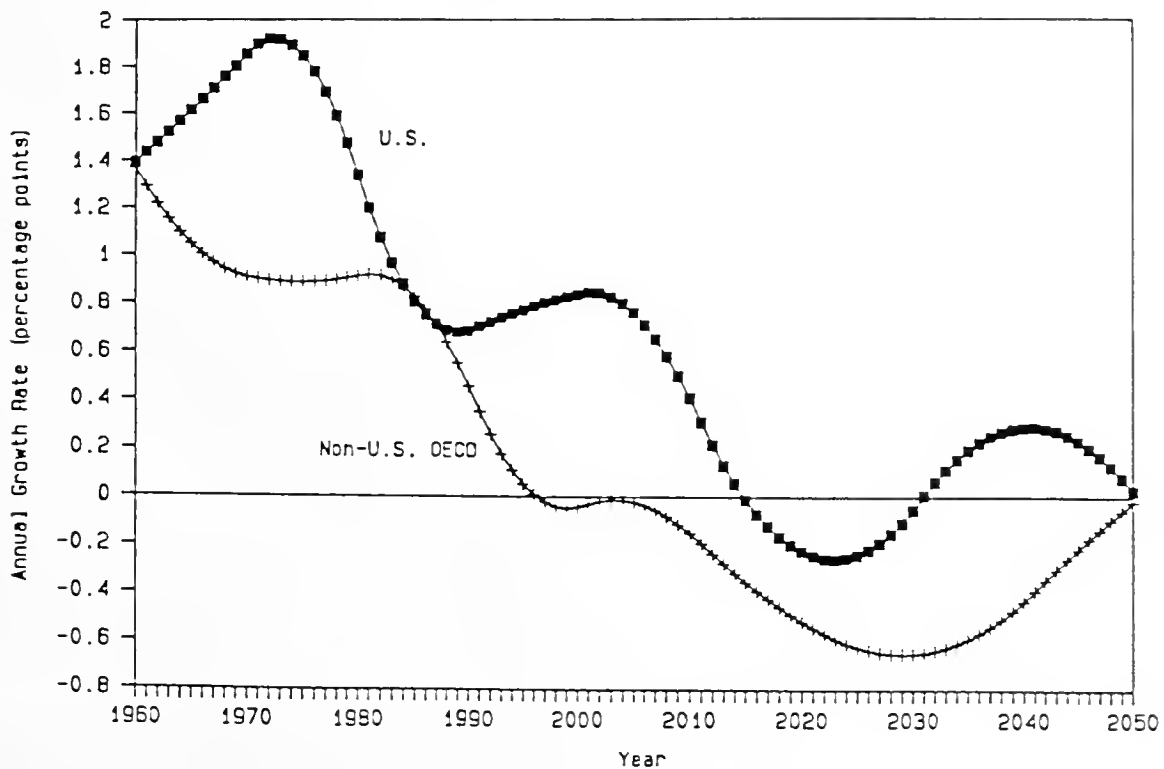
<sup>27</sup>We use the equivalence scale measure of consumption needs, with the same weights as for the U.S.

Figure 3.3: Demographic Data for  
the U.S. and non-U.S. OECD

(a) Support Ratios



(b) Labor Force Growth



Note: The Figure uses the LF2 and CON2 measures of labor force and needs.

The common capital-labor ratio is a weighted average of asset holdings in the two nations:

$$(3.2) \quad k_t = \theta_{1,t} * a_{1,t} + (1 - \theta_{1,t}) * a_{2,t}.$$

where  $\theta_{1,t}$  is country 1's share of world population. From (3.2) we derive the capital accumulation constraint for the two-country model:

$$(3.3) \quad \dot{k}_t = \dot{\theta}_{1,t} * (a_{1,t} - a_{2,t}) + \theta_{1,t} * \dot{a}_{1,t} + (1 - \theta_{1,t}) * \dot{a}_{2,t}.$$

This constraint replaces equation (2.4), in the one-country model. The optimal consumption profile (2.5) and the steady state saving-investment relation (2.6) are identical to those in the one-country case.

We calibrate the two-country model assuming that both countries have Cobb-Douglas production functions and logarithmic utility functions. We assume that one nation is the United States and the other is the non-U.S. OECD, and set the relative labor force in the U.S. at four-tenths of the two-country total, roughly the value of the productivity-weighted U.S. labor force share for 1990. In addition, we begin the simulations assuming no net foreign investment position.<sup>28</sup> We also assume equal rates of technological progress and equal discount rates in the two countries.

Table 3.2 presents the two-country simulation results. We normalize consumption to be 100 initially in both countries. While the shape of the consumption response is similar in the open and closed economy cases, the magnitude of the responses are different. For the U.S., the closed-economy analysis suggests a 0.1% consumption increase relative to the 1990 steady state. With capital flows between the relatively slowly-aging U.S. and the

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<sup>28</sup>This corresponds to the average U.S. net foreign asset position during the 1980s, but understates foreign holdings of U.S. assets at the beginning of the 1990s.

Table 3.2: Two Country Simulation Results - U.S. and Non-U.S. OECD

	United States		Non-U.S. OECD	
	Con- sumption	Foreign Capital Ownership	Con- sumption	Foreign Capital Ownership
Initial				
Steady State	100.0	0.0%	100.0	0.0%
Adjustment	101.0	0.0	99.4	0.0
Time Path				
2000	100.8	-5.5	99.2	3.7
2010	100.2	-6.4	98.7	4.7
2020	97.9	-3.5	96.4	2.6
2030	93.9	-4.7	92.4	3.7
2040	91.0	-7.9	89.6	6.7
2050	90.5	-8.7	89.1	7.7
Steady State	90.5	-8.7	89.1	7.7

Note: The table shows the results from the open economy demographic simulation. We use the equivalence scale measure for consumption needs. Consumption is normalized to 100 in the initial steady state. Foreign capital ownership is the percentage of assets in each country that are owned by foreigners. The elasticities of substitution in production and consumption are unity.

more rapidly-aging rest of the OECD, however, the U.S. consumption increase is 1% of the 1990 benchmark. Consumption in the U.S. increases more in the open economy case because high saving elsewhere in the world reduces the rate of return to capital, inducing a positive shock to the value of human wealth.<sup>29</sup>

To finance the additional consumption indicated in the simulations, the U.S. runs a current account deficit. This is apparent in Figure 3.4, which shows the path of net national saving and net investment. The residual is the current account. For about 15 years, the U.S. runs current account deficits, so that over 6% of U.S. assets are owned by foreigners in 2010. High saving for the subsequent 15 years results in current account surpluses and reduces foreign capital ownership to 3.5%. Past 2020, however, with the rapid increase in the number of elderly, the U.S. again runs current account deficits, so that in the steady state almost 9% of U.S. assets are owned by foreigners.

For the non-U.S. OECD, consumption declines 0.6% when trade with the United States is permitted. The availability of investment projects in the U.S. means that higher saving in the short-run will not depress rates of return by as much as in the closed economy case.

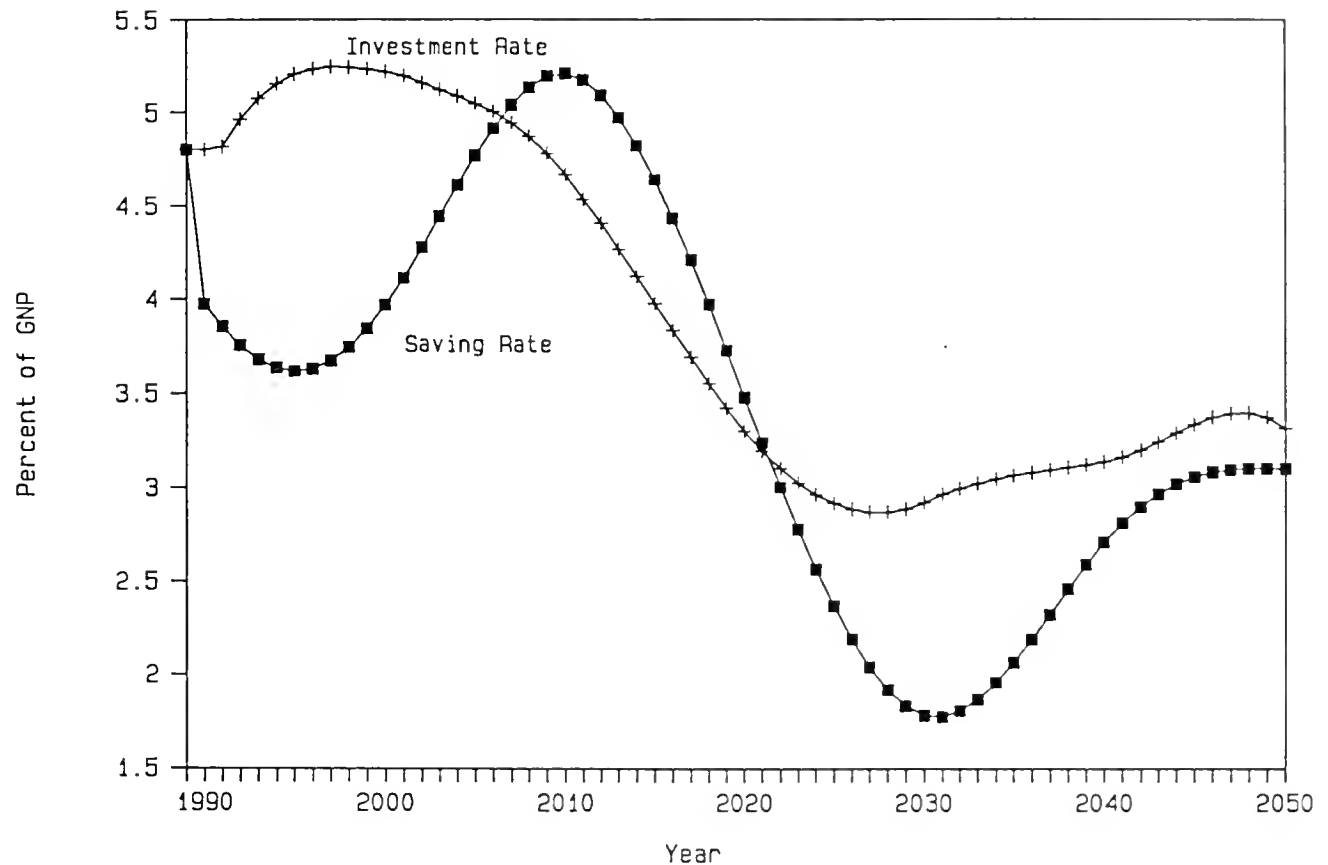
The open- and closed-economy cases yield different consumption levels in both the short-run and steady-state. In the open-economy case, U.S. consumption is higher in the early stage of the transition because of the availability of foreign capital. The resulting decrease in asset accumulation

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<sup>29</sup>Although we assume that utility is logarithmic, the interest elasticity of savings is positive. When interest rates increase, holding wealth constant, saving is unaffected. However, with higher interest rates, the present discounted value of labor income decreases, and hence consumption falls. Wages in the U.S. also increase in the short run.



Figure 3.4: Net Saving and Investment Rates,  
United States,  
From Two-Country Simulation



Note: The Figure uses the LF2 and CON2 measures of labor force and needs.

translates into a 1.8 percentage point reduction in steady-state consumption. For the non-U.S. OECD, the effect is reversed: greater capital accumulation along the transition path leads to steady-state consumption 1.3 percentage points higher than in the autarky steady state.

These results suggest two conclusions. First, the pattern of demographic change in other developed nations can have a large effect on the optimal consumption response to demographic change in the United States. The importance of these effects depends critically on the degree of capital market integration. Second, because the U.S. is aging slowly by comparison with other OECD nations, the optimal consumption response in the open economy entails higher initial consumption than in the autarky case and thus a current account deficit.

#### 4. Demographic Change and Productivity Growth

The foregoing calculations assume that demographic changes affect productivity only by causing changes in capital intensity. The rate of technical change, or equivalently of total factor productivity, was assumed to be independent of demographic developments. A significant effect of demographic factors on technical change, however, would dwarf the impacts on living standards discussed above, and could also have implications for optimal capital accumulation.

There are several potential links between demographic developments and the rate of technological change. One argument, stressed recently by Simon (1980) and Wattenberg (1987), holds that slow population growth reduces the rate of technical progress. The argument has two strands. First, a rapidly growing population enlarges the market for capital goods (the Solow effect noted above), making innovation more profitable by permitting greater spreading of fixed costs. Second, as societies age, they lose some of their "dynamism" and experience slower technical change. French demographer Alfred Sauvy summarizes this view of the future: "A society of old people, living in old houses, ruminating about old ideas."<sup>30</sup> This may occur because the share of the population that is young and innovates declines as population growth slows.

A more optimistic argument due to Habakkuk (1962) holds that incentives to innovate are strongest when labor is scarce. Habakkuk used this to explain why industrialization proceeded faster in America, where attractive agricultural opportunities raised the price of labor, than in England where

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<sup>30</sup>Wattenberg (1987), p.65.

labor was abundant and less expensive. Romer (1990) has formalized this argument and used it to explain the apparent tendency for abnormally rapid U.S. productivity growth in decades of relatively slow labor force growth.

The relative importance of these mechanisms can only be assessed empirically. Unfortunately, there are no ideal experiments for considering the effects of demographic change on productivity growth. Below we draw on the differing demographic experiences of relatively high income countries to try to assess the fear that an aging population will lead to economic stagnation.

#### 4.1 Evidence on Productivity and Demographic Composition

Our empirical work utilizes the 1960–85 international comparison data of Summers and Heston (1990). Unfortunately, data on total factor productivity are not available for a wide sample of countries. Instead, we study the relation between labor force growth and labor productivity growth.<sup>31</sup>

We selected countries with 1960 labor productivity at least thirty percent of U.S. productivity and excluded OPEC countries. This generates a sample of 29 countries. Selecting on initial income avoids the bias of including only countries that have experienced large productivity growth, as DeLong (1988) highlights. We omit countries with very low initial productivity because the role of labor force growth may be very different in pre-industrial societies. Notice that Japan is omitted because its productivity was only twenty-five percent of U.S. productivity in 1960.

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<sup>31</sup>We present limited evidence below suggesting that the difference between labor productivity and total factor productivity does not have a large effect on our results.

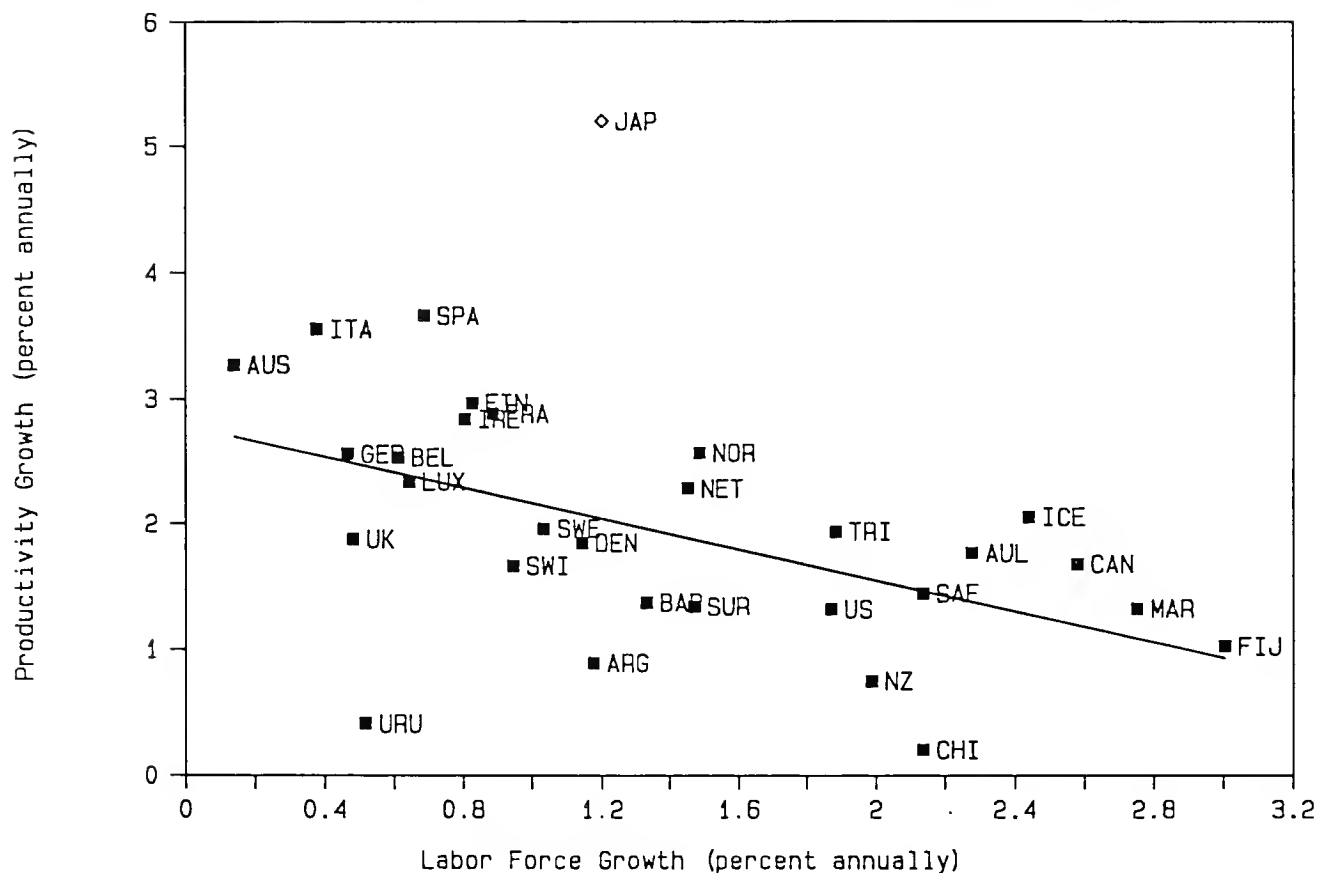
Figure 4.1 plots annual productivity growth versus annual labor force growth for the 1960-85 period. The data show a strong negative correlation. Slower-growing countries, including most European nations, exhibit above-average productivity growth, while more rapidly-growing countries such as Canada and Australia have lower productivity growth.

To control for additional factors affecting growth, we estimate cross section regressions of the form:

(4.1)  $\ln(y_{1,i}/y_{0,i})/T = \alpha_0 + \alpha_1 * \ln(LF_{1,i}/LF_{0,i})/T + \alpha_3 * \ln(y_{0,i}) + \alpha_4 * (I/Y)_i + \epsilon_i$   
 where  $y_{1,i}$  and  $y_{0,i}$  are respectively final and initial output per labor force member,  $LF_{1,i}$  and  $LF_{0,i}$  are the final and initial labor force, and  $(I/Y)_i$  is the average investment rate during the sample period. The investment rate is included to control for changes in capital that affect labor productivity but not total factor productivity. Initial income is included to capture the possibility that lagging countries grow more rapidly as they converge towards leading ones. Productivity growth and labor force growth are expressed at annual rates.

The upper panel of Table 4.1 reports ordinary least squares estimates of equation (4.1). The coefficients in the bivariate regressions, analogous to Figure 4.1, imply that a one percentage point decrease in the annual labor force growth rate raises productivity growth by .62 percentage points per year. Controlling for the initial level of productivity and investment rates has little effect on the labor force growth coefficient, with the estimates still negative (-.64) and large. The data also suggest that more rapid investment leads to faster productivity growth, although there is no evidence of productivity convergence for this sample.

Figure 4.1: Productivity Growth and Labor Force Growth, 1960-1985



Note: The Figure shows annual productivity and labor force growth for the 29 countries with 1960 productivity at least 30 percent of U.S. productivity, and for Japan. Data are from Summers and Heston (1990).

Table 4.1: Demographic Change and Productivity Growth

Period	<u>No Controls</u>		<u>With Controls</u>			
	Labor Force Growth	$\bar{R}^2$	Labor Force Growth	Logarithm of Initial Productivity	Investment Rate	$\bar{R}^2$
<u>A. Ordinary Least Squares Estimates</u>						
1960-85	-.617 (.179)	.281	-.637 (.161)	-.346 (.434)	.063 (.022)	.421
1960-73	-1.061 (.245)	.389	-1.044 (.232)	-.730 (.647)	.064 (.028)	.460
1973-85	-.258 (.198)	.025	-.295 (.195)	.154 (.546)	.075 (.031)	.175
Fixed Effects	-.903 (.477)	.085	-.446 (.355)	-6.290 (1.177)	.032 (.057)	.600
<u>B. Instrumental Variables Estimates</u>						
1960-85	-.711 (.216)	—	-.742 (.189)	-.337 (.438)	.064 (.022)	—
1960-73	-.977 (.297)	—	-.956 (.272)	-.763 (.651)	.064 (.028)	—
1973-85	-.436 (.272)	—	-.610 (.296)	-.150 (.610)	.085 (.033)	—
Fixed Effects	-.840 (1.151)	—	.332 (1.440)	-7.273 (2.174)	-.017 (.107)	—

Note: The dependent variable is the annual productivity growth rate from 1960-1985. The labor force growth rate and investment rate are both annual rates. Data are from Summers and Heston (1990). The sample consists of the 29 non-OPEC countries with 1960 income per worker above 30 percent of the US. The upper panel reports ordinary least squares estimates. The lower panel reports instrumental variables estimates for the growth rate of the labor force with the growth rate of the population.

We estimated equation (4.1) with other samples of countries, with similar results. If we include the six OPEC countries with 1960 productivity above 30% of the U.S. level, the coefficient in the multivariate regression rises to  $-.517$  (.144). If we limit the sample to countries with 1960 productivity at least 50% of that in the U.S., the coefficient becomes  $-.263$  (.192). If we consider the current OECD countries, the coefficient is  $-.372$  (.161). Finally, if we include all 114 countries in the Summers and Heston data with at least twenty years of data, the coefficient becomes  $-.507$  (.159).

The second two rows show the results over two data sub-intervals: 1960–73 and 1973–85. This division allows us to examine the importance of the productivity slowdown in the mid-1970s. The results from these regressions are consistent with those from the full sample, although the evidence is stronger in the 1960–73 period. In the earlier period, the coefficient is much larger ( $-1.044$ ) and still statistically significantly different from zero. In the post-1973 period, the coefficient falls to  $-.295$  and is no longer statistically significant.

The fourth row presents the results of treating the two sample periods as a panel and estimating a fixed effects regression. This specification controls for other factors which can explain persistent differences in growth rates across countries but which are not included in our set of explanatory variables. The results are qualitatively similar to those without the fixed effects. The coefficient in the multivariate regression ( $-.446$ ) is within the range of the estimates for the two sample periods, although the coefficient is not statistically significantly different from zero when we control for initial income and the investment rate.



The lower panel of the table reports instrumental variables estimates of the same equations, using the population growth rate as an instrument for labor force growth. If rapid productivity growth leads to less rapid increases in labor force participation, the ordinary least squares estimates will be biased but the instrumental variables regressions will not. The instrumental variables estimates strongly confirm the ordinary least squares estimates. In the 1960–85 regression, the coefficient on labor force growth becomes more negative in the instrumental variables regression ( $-.711$ ) and is still statistically significantly different from zero. The coefficients on the other variables, in contrast, change little.

As the middle two rows suggest, this is principally due to a more pronounced negative relation between labor force growth and productivity growth in the 1973–85 period. This is consistent with Freeman's (1988) claim that the decline in productivity growth in post-1973 Europe discouraged labor force participation, leading to a positive bias in the coefficient on labor force growth rates.

The final row presents the results for the instrumental variables regression with the fixed effects specification. While the coefficient in the bivariate regression is similar to the ordinary least squares estimate, the coefficient in the multivariate regression is positive. In both cases, the coefficients on labor force growth are not statistically different from zero.

Because reduction in the labor force growth rate tend to increase capital intensity, one would expect them to be associated with increases in labor productivity growth even if they had no impact on technical change.<sup>32</sup> We

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<sup>32</sup>Mankiw, Romer and Weil (1990) explore this possibility, with particular attention to the role of human capital accumulation.

doubt that the equations in Table 4.1 are primarily picking up this effect for two reasons. First, its theoretical magnitude is much smaller than the effects implied by the cross country equations. Over a 25 year period, a reduction in labor force growth holding investment constant would raise labor productivity by at most .17 percentage points assuming a Cobb-Douglas production function with a 67% labor share.<sup>33</sup> Second, for a small sample of OECD countries with available data (18 countries) we have estimated productivity growth equations using both labor productivity and total factor productivity and found only negligible differences in the results.<sup>34</sup>

These regressions imply substantively large effects of demographic change on future growth. Since the annual labor force growth rate is predicted to fall by about one percentage point between 1990 and 2050, with most of the change occurring between 1990 and 2010, our estimates imply an increase of about .6 percentage points in annual productivity growth. Such effects are large enough to offset the decline in living standards that we presented above. Even a .2 percentage point increase in annual productivity growth between 1990 and 2040 would offset the roughly 10% decrease in per capita consumption as a result of rising dependency burdens over that period. Thus,

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<sup>33</sup>The predicted effect is only this large if the base year for our observations (1960) is the first year of the new labor force growth rates. If the countries were already in steady state with different labor force growth rates, there would be no predicted effect on productivity from this explanation.

<sup>34</sup>Without controls for initial productivity and investment rates, the coefficient on the growth rate of the labor force is  $-.788$  (.207) in the equation for labor productivity and  $-.696$  (.257) in the equation for total factor productivity. In the multivariate regression, the coefficients are  $-.305$  (.216) and  $-.259$  (.324) in the two equations.

even if the effects are much smaller than those from our regressions, they are likely to have a large impact effect on future living standards.

The regressions thus far present little evidence for the more pessimistic view of demographic change. It may be, however, that part of the effect of demographic change occurs through the investment rate. If slower labor force growth reduces the rate of innovation because of decreased demand for capital goods, that will show up as a positive effect of investment rates on productivity growth, rather than as an effect of labor force growth.

To consider this hypothesis, we re-estimated the equations in Table 4.1 without controlling for the rate of investment. The results change little from those reported. For the full time period, for example, the coefficient on labor force growth falls only slightly, from  $-.637$  (.161) to  $-.617$  (.182). In no case does the coefficient on labor force growth fall substantially, and in many cases it becomes more important.

It is also possible that our measure of demographic change is not the best measure for examining the productivity consequences of changing population structure. The argument that older workforces are less innovative than younger workforces suggests that a variable like the average age of the workforce is a more direct measure of demographic conditions. Our measure of labor force growth rates is only partly correlated with this type of demographic variable.

We explored this possibility by adding the average age of the labor force to the equations in Table 4.1.<sup>35</sup> In the basic specification in the first row

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<sup>35</sup>To account for changes in the average age of the labor force over the time period of our productivity growth measurements, we defined the average labor force age over any period as the mean of the average age at the endpoints of the period.

of the table, when the average age variable is included, the coefficient on the labor force growth rate declines to  $-.483$  (.225), and that on the average labor force age is  $.135$  (.138). Neither the coefficient on initial productivity nor that on the investment rate change substantially. Similar conclusions emerge for the other specifications.<sup>36</sup>

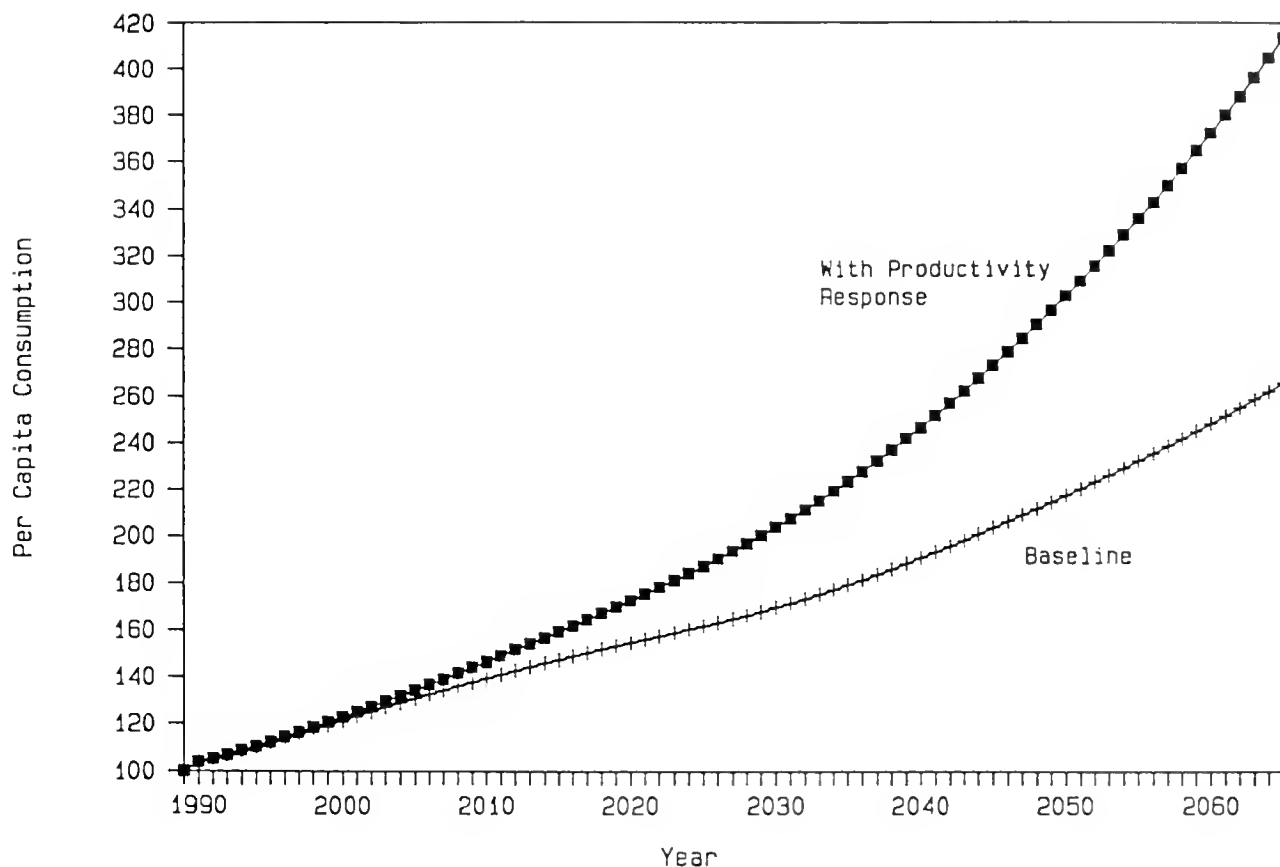
To the extent that the labor scarcity hypothesis is correct, it reinforces our conclusion that the maturing of the labor force expands society's opportunities. Faster productivity growth has a theoretically ambiguous effect on the level of current consumption, however. It tends to increase consumption today because of the income effect of increased output, but this effect can be offset by a substitution effect from the increased return to investment as the effective supply of labor grows more quickly.

To evaluate the magnitude of these effects for current consumption decisions, we calculated the optimal consumption path when productivity growth changes over time. We assumed that each percentage point decrease in labor force growth increases productivity growth by .5 percentage points, a number in the range of those in Table 4.1. Figure 4.2 shows the resulting consumption path, as well as the consumption path without the productivity effects, allowing for a demographic shocks like those examined in the previous

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<sup>36</sup>We intend to explore these issues further in subsequent work. Preliminary results suggest that the evidence for beneficial effects of slow labor force growth is much weaker for the 1870-1960 period than for the post-1960 period. This may be a consequence of the simultaneity caused by much larger immigration flows in the early period. At this point, it seems fair to conclude that there is no international evidence for the dynamism hypothesis that more rapid population growth or a younger population raises productivity, and some evidence for the contrary labor scarcity hypothesis.

Figure 4.2: Consumption Response With Induced Productivity



Note: The Figure shows the path of consumption per person in the baseline simulation and the simulation allowing for productivity to respond to labor force growth. The simulations use the LF2 and CON2 measures of labor force and needs. Productivity growth increases by one-half of one percentage point for each one percentage point decrease in labor force growth.

sections.<sup>37</sup> The effect of increased productivity growth is to increase current consumption even more, by an additional 0.2 percentage points. Further, since most of the productivity benefits occur in the next several decades, when the labor force grows slowly, consumption remains above its initial level throughout the transition path to the new steady state.

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<sup>37</sup>We use the support ratio defined with the earnings-weighted labor force and equivalence scale consumption measure. We also assume unit elasticities of substitution in production and consumption.

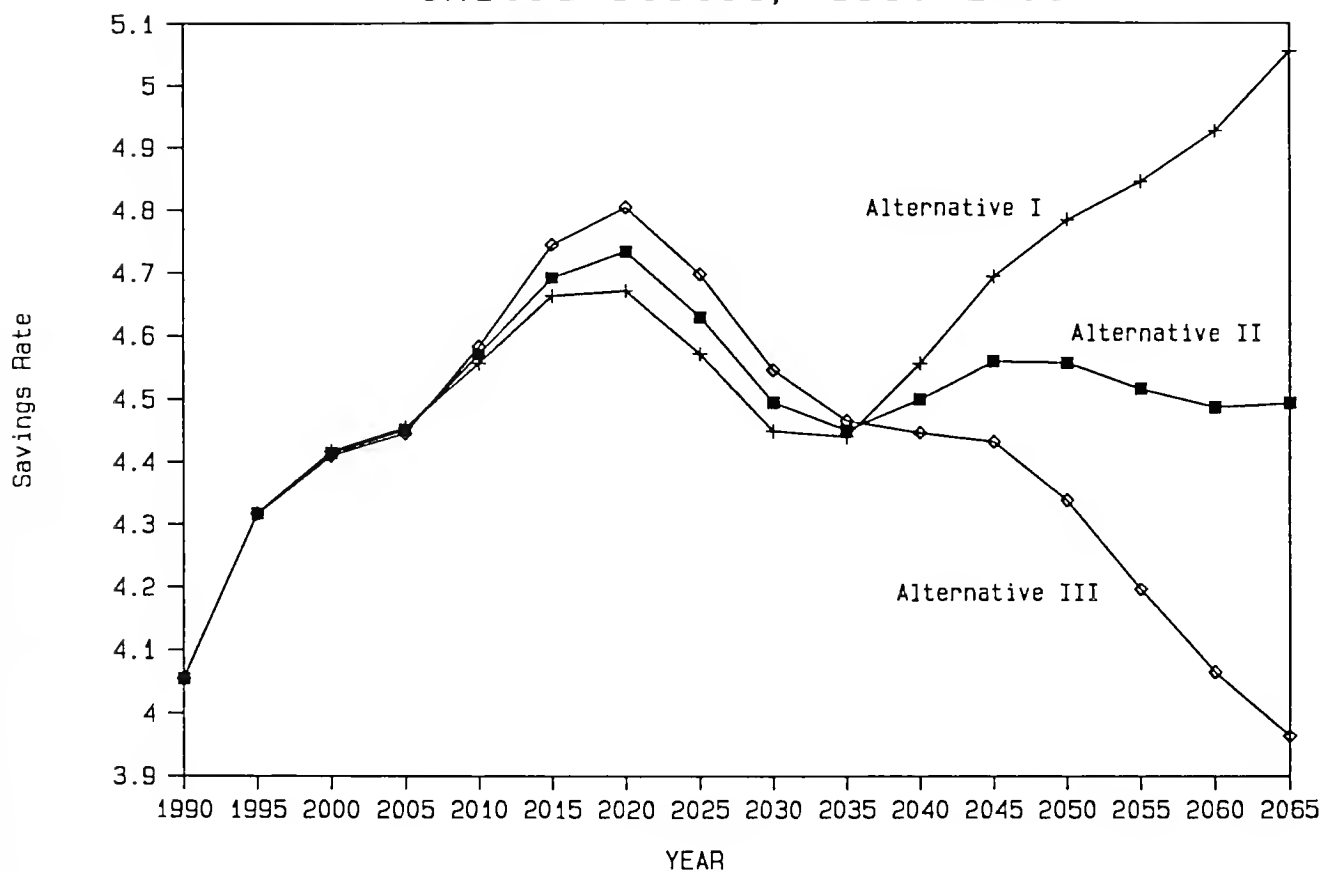
## 5. Demographic Change and Fiscal Policy

The preceding section suggests that, *ceteris paribus*, the optimal response to recent and projected demographic changes is a decline in the national saving rate. The implications for fiscal policy depend on how the private saving rate responds to demographic changes, and on the projected path of government expenditures.

The effect of the population's aging on private saving has been the subject of a number of analyses, but no firm conclusion has yet emerged. From the standpoint of the life cycle hypothesis, slowing population growth and an aging society should be associated with reductions in the private saving rate. As the aged share of the population increases, the ratio of dissavers to savers rises and so the private saving rate falls. David Weil (1989) has recently pointed out that this effect may be reinforced by an increase in expected bequests, and thus a reduction in saving, among the non-elderly population. On the other hand, a number of analysts have argued that the maturing of the baby boom generation will raise personal saving, because contrary to the implications of the simple life cycle hypothesis, people may borrow when young and then save as they approach middle age. Increases in personal saving may also result from people having fewer children.

Summers and Carroll (1987) explore the impact of demographic change on saving behavior by assuming constant age-specific saving rates and then examining how the changing age composition of the population alters aggregate saving rates. Figure 5.1 uses the same age-specific saving rates from their analysis, as well as Social Security Administration population forecasts, to project personal saving rates over the next 30 years. The results suggest that the maturing of the population will be associated with a modest increase

Figure 5.1: Projected Private Saving Rate,  
United States, 1990-2065



Note: The Figure shows projections of the private saving rate,  
holding age-specific saving rates constant. Age-specific saving  
rates are from Summers and Carroll (1987).



in saving rates during the next four decades. Calculations by Auerbach and Kotlikoff (1989) reach similar conclusions.<sup>38</sup> A near-term increase in private saving provides a further reason why an economy with an initially optimal saving rate should loosen fiscal policy in response to changing demographic conditions.

There is, however, a different argument for a tight fiscal policy. Projected demographic changes imply significant fluctuations in the level of government spending over the next century, since transfers to the elderly are much larger than those to any other group. Efficiency considerations argue for higher current taxes to fund foreseeable increases in government outlays. Since the deadweight loss of taxation increases with the square of the tax rate, financing the anticipated rise in government outlays on a pay-as-you-go basis, with lower tax rates during the next few decades and higher ones in the middle of the next century, entails a larger deadweight burden than a constant tax rate policy.<sup>39</sup> This argument parallels the traditional justification for using debt to finance wars and other transitory shocks to government spending.

To evaluate the empirical significance of tax-smoothing considerations, we begin by describing the age-specific pattern of government outlays. We then present a simple framework for evaluating the efficiency gains from tax smoothing and report suggestive calculations. These findings imply relatively

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<sup>38</sup>Both sets of calculations are flawed in ignoring pension saving, which may change as the age structure of the population changes. They also take no account of changes in the number of children or in the number of persons supporting an aged parent, although these factors affect age-specific saving rates. Weil (1990) uses aggregate data on OECD countries to study saving, recognizing these effects. His findings suggest that private saving in the United States may rise by about 1 percent in the next decade.

<sup>39</sup>Barro (1979) describes the "tax smoothing" view of optimal government financial policy.

small efficiency improvements -- on the order of one percent of one year's GNP -- from stabilizing tax rates throughout the next half century.

### 5.1 Age-Specific Patterns of Government Spending

Governments spend different amounts on individuals of different ages. Outlays on education, for example, primarily benefit children, while the elderly are the principal beneficiaries of most government spending on health care and Social Security. Even without changes in the structure of government programs, demographic shifts can affect the level of government spending.

Table 5.1 presents stylized information on age-specific government expenditure patterns for the United States, focusing on the three largest social expenditures: Social Security, health care, and education. The first column shows spending on OASDI. Virtually all of the expenditures on this program are directed to individuals aged 65 or over, with average outlays in 1986 of \$6138 per person. The second column shows analogous age-specific spending patterns for medical care, with average expenditures per person aged 65+ (\$3526) more than four times larger than outlays for any other age group. The third column reports the age profile of education spending. Per capita expenditures on schools for the younger age cohorts are substantial, reaching \$3353 per year for persons between the ages of 5 and 14. Adding the three programs together, spending on the elderly is more than double that of any other group.

Demographic shifts can significantly alter government outlays. Table 5.2 reports projections of total government outlays as a share of GNP under the assumption that age-specific expenditure patterns remain at 1989 levels for the next sixty years. Primary government spending is assumed to equal a

Table 5.1: Age Distribution of Government Spending: United States, 1989

Age Group	Per Capita Spending (\$1989)			
	Social Security and Disability	Medical Care	Education	Total
0-4	\$132	\$872	\$674	\$1,678
5-14	\$132	\$690	\$3,353	\$4,175
15-19	\$132	\$298	\$2,930	\$3,360
20-24	\$16	\$298	\$1,112	\$1,426
25-44	\$83	\$298	\$233	\$614
45-64	\$811	\$218	\$84	\$1,113
65+	\$6,138	\$3,526	\$84	\$9,748
Total	\$925	\$824	\$873	\$2,622

Note: The sources of the data are described in the note to Table 5.2.

Table 5.2: Projected Government Expenditures (% of GNP), 1990-2060

Year	Social Security	Medical Care	Education	Other	Total
1990	4.7%	4.1%	4.7%	18.0%	31.8%
2000	4.5	5.3	4.9	18.0	32.9
2010	4.6	5.9	4.9	18.0	33.4
2020	5.6	6.5	4.8	18.0	35.0
2030	6.5	7.4	4.9	18.0	36.7
2040	6.5	7.8	4.9	18.0	37.1
2050	6.5	7.8	4.9	18.0	37.1
2060	6.5	7.8	4.9	18.0	37.0

Notes: Social Security and Disability spending are predicted from projected population growth rates. For the 1989 distribution of spending, we projected the year-end 1986 distribution from the Social Security Administration (1987) to 1989, using the GNP deflator. Spending at below retirement ages is the sum of OASDI payments to the disabled, payments to early retirees, and payments to surviving children and spouses. Spending on all persons below 20 years of age was treated as applying uniformly to the members of this group.

For medical care spending, we combined four types of spending. We obtained 1987 estimates of Medicare and Medicaid per capita spending on the elderly for hospital care, physicians' services, nursing home care, and other personal health care from Waldo (1989). For the non-elderly population, we calculated government spending on each of these categories as the difference between the Health Care Financing Administration (1989) estimate of 1987 total government spending for that category and the implied spending on the elderly. This estimate includes both Medicaid spending for the non-elderly and medical care spending for government employees. We distributed this spending by age on the basis of Medicaid spending, as presented in Department of Health and Human Services (1989). All of the estimates were converted to 1989 dollars using category specific projections of 1987-1990 inflation in Health Care Financing Administration (1989).

We forecast spending using estimates of inflation rates for the four categories of spending and projections of the age distribution of the population. Hospital care estimates are from the Social Security Administration (1988b). They imply a steady state inflation rate above general inflation but below the growth rate of output. Inflation rates for the other three categories were projected to 2000 using the Health Care Financing Administration (1989) estimates, and were assumed to grow at the rate of hospital price inflation after that.

Finally, for age-specific spending on education, we obtained 1986 age-specific enrollment rates in school as well as the aggregate amounts spent on primary and secondary education, and higher education. We assumed that all persons under 17 who were enrolled in school were in primary and secondary schools, and all persons 18 and over who were enrolled were in higher education. Spending per person was then the weighted average of the population in each age group and the share of each age group in the two types of education. Our projections assume that education spending would grow at the rate of GNP growth, so that changes in the share of GNP devoted to education change only with changing numbers of young people.

constant fraction of GNP. In these projections, government spending rises from 31.8% of GNP in 1990 to 37.0% of GNP in 2060, with nearly all of the increase due to changes in medical expenditures and transfer programs to the elderly. Our tax smoothing calculation assesses the efficiency gains from smoothing the time path of revenues needed to collect this variable expenditure stream.

## 5.2 The Efficiency Gains from Tax Smoothing

We evaluate the efficiency gain from tax smoothing by assuming that the deadweight burden of raising  $\tau$  percent of national output in taxes is given by

$$(5.1) \quad DWL_t = \epsilon * \tau_t^2 * Y_t / 2.$$

The parameter  $\epsilon$  depends on the elasticities of aggregate supply and demand and  $Y_t$  is national income.<sup>40</sup> The marginal deadweight loss per dollar of revenue raised is  $\epsilon * \tau_t$ . We calibrate  $\epsilon$  by setting the marginal deadweight loss from raising one dollar equal to 30 cents, the upper bound estimate in Ballard, Shoven, and Whalley's (1985) general equilibrium analysis of the U.S. tax system. Their calculation employs 1973 data, when federal and state-local taxation in the United States was 31% of GNP, and therefore implies  $\epsilon \approx 1.0$ .

We assume that a government planner seeks to minimize the present discounted value of the deadweight losses from taxation over a T period horizon:

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<sup>40</sup>If governments set taxes to minimize deadweight loss, the marginal deadweight burden per revenue dollar should be equal across tax instruments. The aggregate tax-to-GNP ratio is then a simple proxy for the level of tax burdens. This convenient assumption neglects the voluminous public finance literature suggesting that marginal deadweight losses vary across tax instruments.

$$(5.2) \quad V = \sum_{t=1}^T (1+r)^{-t} \epsilon \tau_t^2 Y_t / 2.$$

This minimization is subject to an intertemporal budget constraint linking taxes and spending as a share of GNP ( $\tau_t$  and  $h_t$ , respectively) with government debt as a share of GNP ( $d_t$ ). For each period, this constraint is:

$$(5.3) \quad d_t = d_{t-1}[(1+r_t)/(1+g_t)] + h_t - \tau_t$$

where  $r_t$  is the interest rate and  $g_t$  is the rate of output growth.

Summing this forward yields a budget constraint of the form:

$$(5.4) \quad V = \sum_{t=1}^T \tau_t \delta_t = \sum_{t=1}^T h_t \delta_t + d_0 - d_T \delta_T$$

where  $\delta_t = \prod_{s=1}^t \left( \frac{1+g_s}{1+r_s} \right).$

Minimizing (5.2) subject to (5.4) yields first order conditions of the form

$$(5.5) \quad \epsilon \tau_t = \lambda$$

so the optimal policy calls for equal tax rates in each period.

In the case where  $r_t = g_t$ , the benefits of tax smoothing take a particularly simple form. The budget constraint is

$$(5.6) \quad \sum_{t=1}^T \tau_t = \sum_{t=1}^T h_t + d_0 - d_T.$$

If, further,  $d_T = d_0$  then with a pay-as-you-go policy, taxes just cover government spending:  $\tau_t = h_t$ . Under the constant period by period debt-to-GNP policy, the deadweight loss is

$$(5.7) \quad DWL_1 = (Y_0 \epsilon / 2) \cdot \sum h_t^2.$$

The constant tax rate satisfying the government budget constraint is just the average value of government spending, so that

$$(5.8) \quad DWL_2 = (Y_0 \epsilon / 2) \cdot T \left[ \frac{\Sigma h_t}{T} \right]^2.$$

Thus, the reduction in deadweight loss from tax smoothing is:

$$(5.9) \quad DWL_2 / DWL_1 = \left[ \frac{\Sigma h_t}{T} \right]^2 / \left[ \frac{\Sigma h_t^2}{T} \right]$$

For the expenditure path in Table 5.2, the deadweight loss reduction in (5.9) is 0.3 percent.

More generally, the incremental deadweight loss time-varying tax rates depends on the precise time path of taxes and change in debt ratios over the period, and hence on the alternative policy choice of the government. We consider two such policies. The first assumes a constant debt-to-GNP ratio in every year, and the second assumes a constant primary surplus (equal to its value in 1989 of .5% of GNP) in each year.

Table 5.3 presents our estimates of the efficiency gains from tax smoothing. The upper panel presents results assuming a constant debt-to-GNP ratio, fixed at its 1989 level of 50.2%. In this case the pay-as-you-go tax rate rises from 32% of GNP in 1990 to 37% by 2050. The average deadweight loss from this policy, shown in the last column, is 6.23% of the average value of future output. The constant tax rate that achieves the same debt-to-GNP ratio of 50.2% in 2050 is 35.3%. Under this plan, taxes would rise by three percent of GNP — roughly \$150 billion — in 1990. Despite this large change in the debt trajectory, however, the change in excess burden is small. The

Table 5.3: Efficiency Gains from Smoothing Taxes

	Year				Average Deadweight Loss/Average GNP
	1990	2010	2030	2050	
<hr/>					
<u>Constant Debt/GNP Ratio</u>					
Variable tax rate	32.6%	33.5%	36.8%	37.1%	6.23%
Constant tax rate	35.3	35.3	35.3	35.3	6.22
<u>Constant Primary Surplus</u>					
Variable tax rate	32.3	33.9	37.2	37.6	6.52
Constant tax rate	35.7	35.7	35.7	35.7	6.51

Note: For each spending category, total government expenditures are projected to 2060, as described in Table 5.2. The two cases are described in more detail in the text.



average value of deadweight loss is 6.22% of average GNP when tax rates are smoothed. The improvement in deadweight loss averages 0.017% of GNP annually, or less than one billion dollars per year in 1990 dollars. The change in the present value of deadweight losses between 1990 and 2060 equals 1.1% of 1990 GNP, or approximately \$55 billion dollars.

The lower panel in Table 5.3 shows parallel calculations assuming the combined federal and state-local primary surplus equals its 1989 share of GNP throughout the 1990 to 2060 period. The results indicate that the average excess burden-to-GNP ratio under this scenario is 6.52%, compared with 6.51% if the tax rate is smoothed. The difference between these two efficiency costs is similar to that in our first case, 0.017% of GNP. Plausible variations in the our assumptions about the debt-to-GNP trajectory therefore do not appear to have large effects on the efficiency gains from tax smoothing. The general conclusion of these calculations is that there is only a weak tax-efficiency case for pre-funding the expenditure burdens of future dependency increases.

## 6. Conclusions

This paper suggests that demographic changes currently in progress are not likely to have deleterious effects on economic performance in the United States, at least during the next several decades. While increased dependency will reduce living standards by five to ten percent in the long run, demographic changes will be beneficial over the next twenty years. In the short-run, demographic change will have two important effects. First, slowing population growth will permit a smaller share of national output to be devoted to investment in plant, equipment, and housing. Second, the share of the population that is working will rise, largely as a result of the falling relative population of children. These positive effects of demographic change may be reinforced by increased foreign capital inflows and accelerating technical change as firms respond to an increasing scarcity of labor.

Our analysis suggests that recent and prospective demographic changes do not warrant increasing the national saving rate. These changes increase wealth in the short-run, reduce the rate of return to saving, and attract foreign capital. Holding all else equal, their net effect would be a reduction in the optimal national saving rate. Nor do tax smoothing factors represent an important argument for trying to pre-pay the government's prospective liability to support a dependent population. There is little efficiency loss in following a pay-as-you-go policy with variable tax rates.

Our conclusion departs from many analyses, for example Aaron, Bosworth, and Burtless (1989), which recommend accumulation of a large Social Security trust fund to bolster U.S. national saving. These positions are not necessarily inconsistent, however. A first line of reconciliation holds that apart from demographic considerations, American national saving is much too

low right now and that the Social Security trust fund provides a politically convenient way of reducing the federal government's absorption of private saving.<sup>41</sup>

A second potential reconciliation of these views involves questions of optimal intergenerational redistribution. Some argue for using the Social Security trust fund to raise the national saving rate in order to avoid unfairly burdening our children. The primary thrust of this argument — that we need to prepare for the anticipated burden of increased dependency — is exactly what our support ratio calculations reject. This is because the dependency burden is remote, and because slower labor force growth means more rapidly diminishing returns to additional saving. Admittedly, our approach focuses on the economy's year-by-year consumption level, rather than the welfare of individual cohorts. It is therefore poorly suited to addressing arguments that certain cohorts will be greatly disadvantaged without additional capital accumulation.

However, we do not find claims that our children will be unfairly burdened unless we increase capital accumulation today compelling, for two reasons. First, if the fears of inequity were correct, the appropriate response should be an adjustment in the level of prospective intergenerational transfers, not a change in capital accumulation policy. Just as concerns about the income distribution at a point in time are better addressed through

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<sup>41</sup>The decline in the private saving rate from an average of 7.1% during the 1970s to about 3% during the 1986–1989 period is greater than what our analysis suggests can be justified by demographic factors. There are even some reasons for advocating an increase in the U.S. national saving rate to levels above those observed historically, particularly in light of the emerging need for capital in Eastern Europe and the signs that saving is declining outside of the United States. See for example Hatsopoulos, Krugman, and Summers (1988).

transfer policies than through changes in the mix of products produced, transfers are the right way to respond to concerns about intergenerational equity.<sup>42</sup>

Second, other considerations operate to make the baby boom generation less well off than its successors. The baby boomers systematically loose because of their large cohort size. During their working years, wage growth is slow because of low capital labor ratios. During their retirement years, the number of potential purchasers of capital will fall, thereby reducing the rate of return on saving.<sup>43</sup> Moreover, given productivity growth, the next generation will be considerably more affluent than the current one. If slower population growth or foreign capital inflows accelerate this tendency, the case for intergenerational redistribution is reduced. Even with our estimates of the path of optimal consumption, along which a declining support ratio reduces consumption, the lifetime utility of a person who lives for eighty years rises for those born from 1990 until 2020. Only after 2020 does the lifetime utility of new cohorts fall below that of their predecessors.

Our aggregate analysis cannot resolve policy debates about raising the birth rate or increasing immigration, since these debates often focus on microeconomic effects and distributional consequences of demographic policies. Moreover, there is a fundamental political difficulty of deciding "who is us". How should the welfare of immigrants be treated in deciding whether or not to

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<sup>42</sup>This is the central point made by Calvo and Obstfeld (1989).

<sup>43</sup>Mankiw and Weil (1989) predict that real house prices will fall by almost 50% over the next twenty years because of demographic changes. While their results may overstate the coming decline, even small reductions in house prices would transfer large amounts of wealth to people who are very young today.

accept more of them? How should the utility of an otherwise unborn child be treated? Policy recommendations are impossible without a clear philosophical resolution of these questions.

Our analysis does, however, cast some doubt on the view that in narrow economic terms, higher fertility is helpful in reducing the burden of dependency in old age. Dependency at the beginning of the life cycle is between fifty and one-hundred percent as costly as dependency at the end of the life cycle. It also comes sixty years earlier. Furthermore, the weak available evidence suggests that slower population growth may raise productivity growth.

For the set of issues captured by our analysis, there is a stronger case for increased immigration as a way of reducing dependency. Most immigrants arrive as young adults and so begin working without being dependents first. To the extent that they immediately start paying taxes for the support of the elderly, they may increase economic welfare of the preexisting population, even if they are ultimately eligible for transfer payments in old age.

We have only scratched the surface in assessing the macroeconomic implications of demographic change. Among the main priorities for future research, we would include the following. First, any effects of demography on the rate of technical change are likely to dwarf its other consequences. It would be valuable to refine our estimates by considering data spanning longer periods, and by experimenting with alternative control variables. Second, how demographic changes affect private saving remains uncertain. Investigating the international experience on this question seems worthwhile, particularly if long term data can be marshalled. Third, our calculations have assumed that the non-medical care needs of the elderly are equal to those for the non-

elderly. Whether this assumption is correct, and whether it will remain correct as the aged population ages, needs to be investigated. Fourth, it would be useful to more systematically analyze the impact of demographic changes on the welfare of different cohorts. This would require a life-cycle analysis of the questions we address with an infinite horizon setting.<sup>44</sup> It would also be useful to explore the microeconomic implications of changing demography. For example, our aggregation of capital may well be inappropriate if demographic change alters the relative demands for housing and non-housing capital. Similarly, demographic changes may have important implications for the labor market position of aged workers, and for the relative demands for workers in different occupations.

Further research on these and other related topics is likely to refine the conclusions about demographic change reached here. We doubt that it will alter our primary conclusion that demographic change provides opportunities as well as challenges.

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<sup>44</sup>Auerbach and Kotlikoff (1987), and Auerbach, Kotlikoff, Hagemann, and Nicoletti (1989) use a life cycle model to consider demographic issues, but they assume counterfactually that consumers actually vary their saving rates as the model would predict and do not use the model for normative analysis.

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